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A

TREATISE

ON

GUN-SHOT WOUNDS,

WHICH OBTAINED THE PREMIUM

GIVEN BY THE

ROYAL COLLEGE OF SURGEONS IN LONDON

FOR THE YEAR 1803.

By THOMAS CHEVALIER, F.L.S.

SURGEON EXTRAORDINARY TO THE PRINCE OF WALES,
SURGEON TO THE WESTMINSTER GENERAL DISPENSARY,
AND LECTURER ON THE THEORY AND PRACTICE OF
SURGERY.

Πολλας δ' ἰφθίμους ψυχας ἄϊδι προϊαψεν
Ἡρώων. HOM. IL. 1. 4.

THIRD EDITION.

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TO THE KING.

SIRE,

TO promote the happiness, and alleviate the sufferings of Your people, has been Your Majesty's unceasing endeavour, during a long and beneficent reign.

This encouraged me to implore Your Majesty's gracious acceptance of the following Treatise; which was written in hope of contributing to the relief of those brave and meritorious persons, who may be wounded in the present most just, and arduous contest with the enemies of their Country.

Should it happily conduce to this end, it will be greatly owing to Your Majesty's condescension, in permitting it to go forth under the sanction of a name so truly illustrious, and so justly endeared to every Briton.

That Your Majesty may long continue to reign over a prosperous and united people, and that the British Throne may be filled by Your Majesty's Posterity, with increasing honours, to the end of time, is the fervent wish and prayer of

Your Majesty's most loyal,

and most dutiful

Subject and Servant,

THOMAS CHEVALIER.

South Audley Street,
June 1, 1804.

PREFACE.

I Had for some time meditated the composition of a small treatise on Gun-shot Wounds, when the Royal College of Surgeons, in the year 1801, announced them as the subject of a Prize Dissertation. This induced me to lay aside my intention, the fulfilment of which, I thought would probably be rendered unnecessary. But finding they were again proposed as a Thesis for last year, and thinking the circumstances of the times made it desirable that something should appear on the subject, I resolved to commit my ideas to writing, and to submit them, unknown, to the judgment of the College.

By this method I was sure of obtaining the unbiassed opinion of competent judges in the first instance; and their decision having been in my favour, I am more satisfied, than if I had merely asked the opinion of any friend, as a friend, or trusted entirely to my own.

It may however be proper to observe, that the object I have had in view in writing this treatise, has simply been, to make a faithful and correct investigation of the characteristic phænomena of Gunshot Wounds; to explain their effects upon indisputable principles in physiology and pathology, to point out those processes by which only nature can repair all that is reparable in such a complication of violence; and to deduce from thence that treatment by which she may be most effectually assisted in her

work, and the obstacles to her performance of it in the best and safest manner, may be either prevented, or removed.

Some persons would probably have taken up the subject in a different way, and might nevertheless have written well upon it. Let them not however blame me for not doing exactly what they would have done, but which it formed no part of my intention to do. I thought a work on Gun-shot Wounds, written expressly to elucidate their pathology, and to show the PRINCIPLES on which the treatment of them should be conducted, and by which the variations required in that treatment under peculiar circumstances might be ascertained and adjusted, was really wanting. Such an one therefore I endeavoured to compose; and I have more hope of utility from it, than if I had

crouded it with cases, and circumstantial descriptions of many particular wounds. A Surgeon may look at a particular accident, or disease, as a painter may look at a particular face, or a particular landscape, till his mind is absorbed by petty circumstances, and he is unable to retain the grand outline, which alone can shew him to be a true master of his art. Some persons will hear nothing talked of but experience, without well considering what experience is; and that nothing is more deceitful on many occasions, than what is commonly called by that name. "*Inductio enim quæ procedit per enumerationem simplicem, res puerilis est, et precario concludit, et periculo exponitur ob instantia contradictoria: Et plerumque secundum pauciora quam par est, et ex his tantummodo quæ præsto sunt, pronun-*

ciat." * And hence it follows, that unless general principles be first known, and carefully applied, particular instances will be very liable to mislead us; as they have formerly misled the greatest men, who did not, in this respect, possess our advantages. Not that I object to the introduction of cases. Far from it. I have introduced some, which I think to be important, and I could have introduced many more, but for the reason I have alledged: It did not accord with my plan. Moreover, many cases are already on record, and are therefore accessible to the reader. But individual cases are to be consulted occasionally; and for the sake of illustration and deduction: General principles are always to be remembered. Let them only be true, let them all be taken into the account, and pro-

* Bacon, Nov. Org. I. 105.

perly balanced against each other, and they will both explain particular occurrences, and will be explained and illustrated by them. He who is most perfectly master of them, and has the greatest facility in applying them, is most likely to be minute, where minuteness is of consequence; but he will at the same time be so single-eyed with regard to material points, as to treat things of secondary import as no more than secondary. He will mark them truly, though not chiefly; and will notice them in their place, but not beyond their actual and relative importance.

These observations, if rightly understood, will not be found in any degree at variance with those I have quoted in the first chapter of this work from Lord Bacon. For indeed, general principles

if they be true ones, are nothing more or less than statements of general facts. They are the AXIOMATA, of which he speaks; *a particularibus ritè, et ordinè abstracta; quæ nova particularia rursus facilè indicant, et designant.* ITAQUE, as his Lordship justly adds, SCIENTIAS REDDUNT ACTIVAS. Well has he therefore observed in another place, *Vaga Experientia, et se tantum sequens, mera palpatio est, et homines potius stupefacit quam informat. At cum Experientia* LEGE CERTA *procedet,* SERIATIM, ET CONTINENTER, *aliquid melius sperari poterit.**

Such then having been my object, while I hope my labour will not be in vain, I am desirous that the reader should avail himself of every other assistance by which he can perfect his knowledge of the

* Nov. Org. I. 100.

subject, and illustrate the doctrines, or supply the deficiencies he may observe in this treatise. I would particularly recommend his perusal of the small, but masterly work of Le Dran on Gun-shot Wounds, which I once had a thought of translating, and publishing, with such alterations as would comport with our later improvements. But I soon found that these must be so numerous as to make it not worth the trouble. I cannot however withhold my praise from a treatise, which I never take up without pleasure. The work of Ravaton is excellent in its kind. Those of the late Mr. Hunter, and of Mr. John Bell on the same subject, notwithstanding their difference in some particulars, are also well worth an attentive perusal. Nor must I omit to mention the excellent observations of Sir William Blizard, subjoined to the third edition of

his Lecture to the Maritime School*. In these works will be found the substance of most, if not of all, that can be collected from former writers; freed from a number of errors, and enriched with many solid and judicious remarks. Many cases however, recorded in the Memoirs of the Royal Academy of Surgery at Paris, and in other works both in French and English (not forgetting the writings of old La Motte, and Mr. Serjeant Wiseman) will be of use to the student, if the circumstances in them which are of real importance be properly discriminated from the rest, and from the obsolete theories with which they are intermixed.

* I regret that the second edition of my book was entirely printed off, and ready for publication, before I had the good fortune to meet with Sir William Blizard's valuable remarks. It gave me great pleasure to find my own ideas so entirely coincided with those of that able and excellent Surgeon.

But it is not by the study of any one practical subject alone, that a man can make himself fully master, even of that subject. To survey an object with accuracy, it must not only be seen near, and by itself, but also at a distance, and in its combination with others. He therefore who wishes thoroughly to understand the nature and treatment of Gun-shot Wounds, must bring to the contemplation of them, a mind furnished with a knowledge of the general principles of his art, and of medical science at large. His way will then be comparatively clear; and he will find the interest and importance of the subject increase in his estimation, while by attention and experience its difficulties will diminish.

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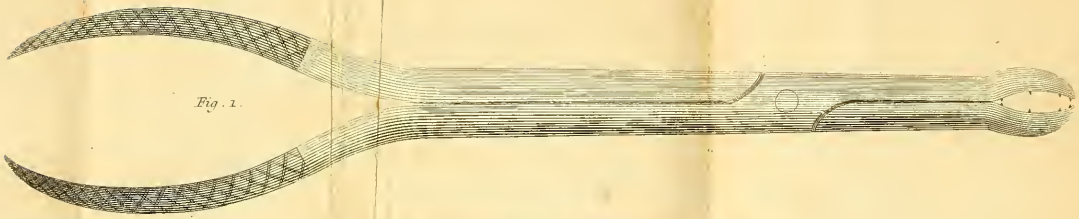

Fig. 1.

Fig. 3.

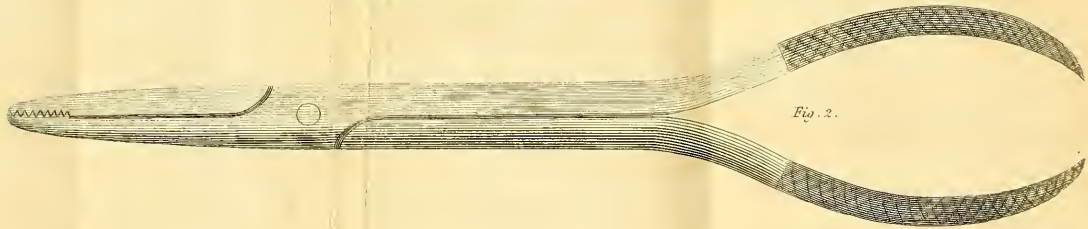

Fig. 2.

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Silvester sc. 27 Strand

EXPLANATION OF THE PLATE.

Fig. 1. Represents a pair of the Forceps for extracting balls, which are mentioned in page 95.

Fig. 2. Represents a pair of Forceps for extracting loose pieces of bone, cloth, &c.

Each kind are made both strait and curved.

Fig. 3. Represents the claw of another pair, resembling the former in the rest of their construction, which I ordered for the extraction of a very large internal exfoliation from the Tibia. It had remained there upwards of twenty years, and had become almost completely encased in new bone. By this instrument I succeeded first in splitting, and afterward in extracting it; to the great relief of the patient.

I have since used the same instrument in several similar cases with the most decided advantage.

ON

"GUN-SHOT WOUNDS, AND THE BEST MODE OF TREATING THEM."

PART I.

AS I do not conceive it necessary for the elucidation of this subject, to begin the consideration of it with an enumeration of the opinions formerly entertained respecting wounds inflicted by Gun-shot, I shall immediately proceed to consider the nature of such wounds, and afterward endeavour to deduce from thence the treatment which they require.

A Gun-shot wound is a wound made by a blunt instrument, impelled with great velocity into the living solid.

A wound of this description must therefore necessarily produce more or less of contusion and laceration of the wounded parts; will often be accompanied with hæmorrhage; the fracture of a bone; and, in many instances, with the lodgment of extraneous substances. Such a wound, moreover, admits of infinite variety in its extent and direction, both which are regulated by fixed laws, although we cannot in many instances completely develop their operation.

From this account of a Gun-shot wound, it must be evident, that in order fully to understand the nature of such wounds, it is necessary to understand the nature of wounds in general; the nature of contusion, laceration, hæmorrhage, and fracture; the operation of extraneous substances on the living solid; and the laws by which the course and effect of bodies in motion are necessarily determined.

On these particulars I shall therefore first proceed briefly to treat, in the order in which they have been enumerated.

I. ON THE NATURE OF WOUNDS IN GENERAL.

A wound is the sudden division of any part of the body by mechanical violence. —Now as the parts of a living body are exceedingly various in their structure and office, wounds would unavoidably differ much from each other, although the division were effected in them all in the most simple manner, and the constitution of the patient were in all cases healthy. There are, however, some properties necessarily inherent in all living parts, as such, in which therefore they all agree, and in consequence of which, a division of any of them is always attended with certain phænomena.

All the soft parts of the human body, for instance, possess more or less of contractility, vascularity, sensibility, and irritability. And it is in consequence of these properties, that when such a

part is divided, the edges of the wound recede from each other, its vessels effuse their contents, the sensation of pain is excited, and those actions are called forth, by which the repair of the injury is afterward to be accomplished. The same phænomena likewise take place in the wound of a bone, with the exception only of a natural retraction of the edges of the wound, which, in such parts, is prevented by the hardness they derive from the phosphat of lime in their composition.

But as a division of any part may be produced in different ways, and under different circumstances, a wound in any given part, may, in consequence of these, be followed with more or less of retraction, more or less effusion of blood, more or less pain, and more or less of energy, or of regularity, in the processes by which its cure is to be brought about.

Moreover, as the properties which have been mentioned reside in very different proportions in different parts, some parts being more contractile, some more vascular, some more sensible, and some more irritable than others, another source of variety in wounds arises from thence. And this variety is still farther increased, by the great difference in the functions of parts, and their consequent importance to other parts, or to the whole of the body. To all which must be added, the great diversity in the natural constitutions of men, not only in a state of health, but especially under the influence of disease, or other circumstances, affecting either their bodies, or their minds, or both.

But whether a wound be simple or complicated, and whether the part injured be of great or of little importance in the animal œconomy, nay even whether the constitution of the patient be healthy or diseased, his mind tranquil or

disturbed, the repair of the violence, so far as it is possible for it to be repaired, is the work of nature alone; and altogether depends on those living actions which are excited in a part wounded, and in the constitution, for that express purpose. The supply of the materials necessary for reuniting the divided surfaces, as well as the accomplishment of the reunion after the intervention of such materials, being entirely dependent on the principle and actions of life, which no dead matter, or mechanical or chemical agency, can either imitate, or supply. Art may indeed remove obstacles to the performance of these actions, and in many instances it can, by the employment of remedies, excite them if they are languid, repress them if they are excessive, and, to a certain degree, govern them if they are irregular: but it can never substitute any thing instead of them. The maxim of Lord Bacon should therefore be deeply engraven on the mind of every Surgeon—"*Ad opera nil aliud*

" *potest Homo, quam ut corpora natura-*
" *lia admoveat et amoveat: reliqua na-*
" *tura intus transigit.*" Nov. Org. Lib. 1. Aph. 4.

It may be here observed, that the truth of this axiom does not lesson, on the contrary, it must greatly increase the Surgeon's labour. His task would indeed be easy, could the edges of a wound be united by means as simple as the surfaces of two boards may be united. But as the union of the former depends upon the actions of life, in a variety of living parts, he ought to know those parts, to be acquainted with those actions, and with the influence of occasional circumstances, and of foreign substances upon them. And he must learn all this by observation and experience. For to refer again to Lord Bacon, " *dicendum est apertè, nul-*
" *lum rectè fieri potest judicium de via*
" *nostra, nec de iis quæ secundum eam*
" *inventa sunt, per* ANTICIPATIONES.—
" *Subtilitas naturæ subtilitatem argumen-*

" *tandi multis partibus superat; sed axio-*
" *mata a particularibus ritè et ordine ab-*
" *stracta, nova particularia rursùs facilè*
" *indicant et designant.*" Aph. 33. 24.

But to proceed. As a restoration of the continuity in a wounded part is the work of nature alone, the processes necessary to the accomplishment of this work, are commenced from the very instant the injury is inflicted. The commission of the violence gives, as it were, an alarm to the constitution, so that out of its customary operations, it immediately begins to set on foot a series of new ones, strikingly varying from the old, but nevertheless beautifully resembling them; and these continue till the breach is repaired, when they finally cease, and every thing returns to its ordinary course.

Hence in a simple wound, made by a clean cutting instrument, the circulating fluid, now intercepted in its course, and extravasated on the surface of the wound,

speedily coagulates, and shuts up the orifices of the vessels through which it flowed. These vessels themselves contract, and being now no longer continuous tubes, recede, and hide their little mouths in the reticular texture which connected them together. If now the cut surfaces are placed and retained in close contact with each other, the thin stratum of coagulated blood, which the most exact apposition that is required need not altogether exclude, remains upon them; or if it have been removed, its loss will be supplied by a fresh exudation of coagulable lymph. For the arteries which border on the wound, and are yet uninjured, augment the force of their contractions, and thus derive more blood into themselves, and the trunks from which they branch off, in order to supply this material. New and minute vessels arise from their sides, enter this substance, and begin to traverse the wound; and this process taking place in both lips of the wound, they at

length inosculate together *; each species of living substance which was injured sending forth its own tribute of vessels to repair its own loss, and each forming new fibrils of its own peculiar structure, out of the common material, till at length, muscle having produced muscle; membrane, membrane; skin, skin, and so of the rest, the wounded part is restored to a state of

* It is astonishing how soon new vessels shoot into the coagulable lymph, when thus interposed in adhesive inflammation. I performed the operation for a strangulated femoral Hernia, on an elderly man, of very impatient temper, at ten o'clock in the evening. Both intestine and omentum were contained in the sac, inflamed, but not adhering. They were reduced, and the wound properly secured. At noon the next day, in a fit of anger, he tore off the dressings, and forced both intestine and omentum again into the wound. I found them now adhering together. In replacing them again, the stratum of coagulated lymph was in parts broken through; and wherever this was the case it bled profusely; but the blood effused from it was considerably paler than common blood. No gangrene had at this time taken place.

integrity, and is again enabled to carry on its functions in the animal œconomy.

Such a wound, when healed in this manner, is said to be healed by the *first intention*. And the union is generally so far accomplished within five or six days, that the wounded surfaces are out of the danger of being separated again without additional violence; and, if the approximation have been exact, the superficies of the wound will often, at the expiration of this period, be covered with cuticle. But it is probable that in all cases an ulterior organization afterward takes place in the new formed substance, by which it is more perfectly assimilated to the respective parts whose separation it is intended to repair. And the period for the accomplishment of this, will vary considerably in different parts, and even in the same part under different circumstances.

If however, the sides of such a wound be not brought into contact, the interstice which is left by their retraction, is of course to be filled up; and this also is done by those powers with which the all-wise Creator of our bodies has endowed them.

For, the bleeding having ceased, the irritation produced by the division of the part, occasions the adjoining arteries to contract more forcibly, and to propel the fluids which pass through them with greater velocity. Minute branches soon begin to sprout off from their sides, through which a part of the circulating fluid escapes, occasioning a serous effusion, reddened with the colouring matter of the blood, to be discharged from the sore. But as these new formed vessels soon acquire powers of action in themselves, they begin to deposit the nutritious portion of the blood over their extremities, and hence the surface of the

wound is covered with a thin, and semi-transparent stratum of coagulable lymph, into which they continue to elongate in clusters, forming a congeries of roundish eminences, called granulations; the surface of which is moistened by a fluid, called pus, which they secrete. This state of the wound is generally produced in four days from its infliction, provided the constitution be healthy: and on its being accomplished, the action of the contiguous blood-vessels subsides, the tumefaction which attended it, gradually goes off, and the sensibility of the part, which was increased during the establishment of the suppuration (to give notice that nature ought not to be disturbed in her operations by the use of the part) becomes also diminished. The granulations then continue to grow, and the dimensions of the wound to contract, till at length, the vacuity that was formed is filled up, and the skin then sends forth its own vessels from the edge, finally

to overspread the sore, and perfect the cure *.

When a wound is healed in this way, more time must necessarily elapse before its cure is completed, than if it were healed by the first intention. The process is also much more complex, and of course more liable to interruption and derangement. Under the most favourable circumstances, it will vary according to the size of the wound, and the greater or lesser vacuity formed by it, as the parts wounded have a greater or less tendency to retract. Yet by this process, not only are simple wounds healed, but in many instances also, wounds in which a considerable portion of substance has been lost.

* Of this progress in the formation of granulations and skin, the author begs permission to say, he has the most demonstrative evidence, in a series of preparations which he has made, during the progress of an investigation closely connected with the subject of this Essay.

But it is not every wound in which substance has been lost, that can be fully repaired. The powers of regeneration in the living body are limited. The extremities of parts are in hardly any instance restored: but if the extremities remain uninjured, and are well furnished with blood-vessels, a very considerable loss of their intermediate substance will be often supplied.

Such then is the nature of a wound produced by simple incision with a clean instrument. But Gun-shot wounds are not produced by simple incision. On the contrary, they are effected by violent contusion and laceration. We must therefore endeavour to analyse these species of violence, and see what difference they produce in the condition of the wounded part, and in the steps which are necessary to accomplish its cure.

II. ON CONTUSION.

Contusion is that effect which is produced upon the living solid by resistance to a blunt substance, applied or impelled with sufficient force to derange its organization.

If a substance capable of producing this effect be applied slowly, so that we can watch the progress of its operation, the following phænomena will be found to attend it.

First of all, The fibrils composing the texture of the part, and those immediately connected with them, will be *distended,* in an inverse ratio to the resistance.

Secondly, The fibrils comprized within the area of the surface of the substance so applied, will be *compressed,* between it

and the resistance, in a direct ratio to the resistance.

Thirdly, Their organization will be more or less *broken through,* by the excess of compression: which excess of compression will be determined in its extent and degree, by the area of that surface of the substance which acts in producing it, by its momentum, and by the seat, and strength of the resistance.

Lastly, The fluids which the vessels of the part thus bruised would otherwise have continued to transmit, will be intercepted in their progress, and if there be not an external wound which allows of their escape, will be effused, as the case may be, either into the adjoining spaces of the cellular membrane, or an internal cavity, or into the vacuity formed by the breaking down of the fibres which have been destroyed in the contusion.

The discharge of blood, however, is

rarely equal in cases of contusion, to what would follow an equal solution of continuity, produced by more simple violence; because the sides of the vessels are forced together by the compression, and are not able immediately to recover themselves.

In some instances, the whole of the resistance is afforded by the texture and bulk of the part, in which the contusion takes place; in others, it is afforded by a third substance of greater solidity; in which case the contusion, *cæteris paribus*, will necessarily be more violent.

From this account of contusion, it will be evident, that from this species of violence, the texture of some fibres will be weakened, that of others will be broken through, and some portions of them will be absolutely killed, and rendered useless, or even injurious, to the parts with which they were formerly united.

Those portions however which are killed by contusion, are not always immediately detached by it from their connection with the living portions. But this detachment must take place before the injury can be thoroughly repaired; the dead particles being incapable of an immediate re-incorporation with the living. The separation therefore of the dead particles is the first operation which nature has to perform; and where there is an external wound, it is effected by the process of suppuration; which, at the same time that it performs this salutary office, generally places the remaining living parts in a condition to commence the supply of what has been lost.

But the quantity of substance lost is not always confined to that which is immediately destroyed in the contusion. For, as the separation of this is effected by an increase of action in the contiguous living parts, and as some of these parts are in almost every case considerably

weakened by the injury, the increased action which ensues in them, will often be too great for their remaining living powers; and hence all such fibres, or particles, as are in this degree debilitated, will die, and must also be detached. And if any parts have been deprived of all communication with such blood-vessels as are essential to their nourishment, from those vessels having been involved in the contusion, the death of such parts must necessarily take place, and add to the quantity of substance which is necessary to be removed, and which is called the *Eschar,* or *Slough.*

From hence it is evident that the greater the debility, and the more violent the action, which ensues upon contusion, the greater, *cæteris paribus,* will be the sloughing which follows.

Concerning the separation of an eschar, or slough, physiologists have advanced different theories. Some have supposed

it to arise from the putrefaction of the dead substance; others from the interposition of the pus betwixt the dead and the living substance; and others from the absorption of a stratum, either of the dead, or the living. And it must certainly be admitted, *a priori*, that either of these causes might produce the effect which is ascribed to them, and it is even probable that in some instances, they all of them concur to produce it.

Nevertheless, we must take care not to be misled by a regard for any particular hypothesis, and to adhere to the rigid evidence of facts, when we attempt to give an account of any operation of nature. There can be no doubt that as soon as any portion of animal matter becomes dead, it immediately becomes liable to decomposition; and that the species of decomposition which is called putrefaction will take place, if the part so destroyed be under circumstances which favour it. But with regard to the sepa-

ration of an eschar, it is clear, not only that it often takes place too soon to be accounted for by this process alone, but that the actual separation is accomplished at that superficies, or stratum of the eschar, which is farthest removed from the principal requisite to putrefaction; namely, the contact of the circum-ambient atmosphere: The dead part separating, not by a total dissolution of its substance, from the operation of any chemical affinities on its whole mass, but by some process that takes place adjoining that surface of it, that was immediately connected with the living solid from which it exfoliates.

It will also be found, that the separation of an eschar is in many instances promoted by preventing its putrefaction. Putrid matter in all cases debilitating the living parts with which it comes in contact, and thus impeding every process which depends on the powers of life.

With regard to the absorption of a stratum, either of the dead or of the living substance, it may be remarked, that it is difficult to conceive how a solid can be absorbed, without either being converted into a fluid, or intimately incorporated with one. Now if either of these take place, either with respect to the matter of the living part, or of the eschar, the separation must be thereby actually accomplished, and the supposition of absorption becomes unnecessary.

That such a change is actually wrought on the matter of that surface of the eschar which adjoined the living parts, is evident from the appearance of it when detached: especially where, as in a bone, the process takes place slowly, and the exfoliation retains its figure; which will rarely or never exactly correspond to that of the surface it has quitted, and will often bear evident marks of erosion and decay.

If the surface from whence such an

eschar has just been detached, be immediately examined, it will, in almost every instance, bear the marks of growing, and not of decaying parts. Incipient granulations will be found dispersed over it, and the appearances will not justify the supposition of absorption having taken place, at least from the living solid.

But where contusion takes place without an external wound, there is the clearest evidence, not only that the fluids extravasated in the injury, but also the particles that are killed, are often completely absorbed, and their loss repaired, without any suppuration. In such cases, the inflammation which comes on does not exceed the adhesive stage; the debilitated fibres are therefore preserved in a state comparatively quiescent; time is given for the recovery of their tone, and the parts that were separated are at last re-united by a process, in most respects, if not in all, like that of union by the first intention.

It has been already observed, that the compression which contused parts undergo, often prevents much extravasation of blood from taking place immediately after the accident, except where any considerable vessel is ruptured. But on some occasions large vessels are involved in the contusion, without being ruptured. And then great danger will often arise at the time the eschar is detached, from a portion of such a blood vessel being detached along with it, and occasioning a large, and sometimes dangerous hæmorrhage. The nature of Gun-shot wounds therefore will cause this to take place in a great number of instances.

III. ON LACERATION.

Every wound is a species of laceration: The cohesion of the wounded part being in every instance torn, or broken through, by violence, the force of which must in all cases exceed the force of that cohesion. But in incised wounds the operation of this force is confined to the contact of the wounding instrument, while in what is strictly called laceration it extends farther. A knife, or any other cutting instrument, acts on the principle of a wedge; and divides the parts by interposing itself between them: but in laceration, the part in which the cohesion is broken through, gives way only from the excess of distention. In wounds, therefore, produced by laceration, the division is effected in the most violent manner. And in those parts in which the force of cohesion is strong, especially if they are but loosely attached to those about them, as in nerves, for example,

the operation of the violence will often extend very far indeed; and involve in the injury, not only parts which are immediately adjacent, but others at a considerable distance, and even the sensorium itself.

Laceration then, by the greater injury it does to the parts involved in it, tends to excite a greater degree of sensibility in their nerves, and a greater degree of inflammatory action in their blood-vessels, than would take place, *cæteris paribus*, in an incised wound in the same part, and of the same dimensions; while at the tame time it weakens both the one and the other, and renders the part less capable of sustaining that increased action, than it would have been before the infliction of the injury. In consequence of this it will sometimes die, and slough. And where a muscle, or the trunk of a nerve supplying a muscle, is included in the laceration, irregular, and as they are usually called, spasmodic contractions,

will probably take place in that muscle, in which other muscles will often participate; and in some cases, the nervous system at large will be thrown into a state of disorder; so that Tetanus, which slight injuries to such parts are often sufficient to produce, will be very likely on many occasions to supervene.

The less the resistance is, which the texture of any soft part is capable of affording to a blunt substance passing through it, the greater will be the laceration produced in it by any given momentum with which that substance is impelled. The laceration will also be greater when the substance impelled passes out of a dense medium into a rare one, as for example, out of flesh into air, than where it passes out of a rare medium into a dense one, as for example, out of air into flesh: Because the over distention of the parts will be less counteracted in the former case than in the latter, on account of the diminution of

the resistance. So that the laceration may be greatest where the contusion is least, and *è contrario*. On this account a shot generally makes a larger aperture at the place of its exit, than at that of its entrance: The latter being often depressed and narrow, while the former is elevated, and comparatively wide.

In parts of loose structure, and comparatively unimportant in themselves, such, for example, as many portions of the cellular membrane, laceration is so easily effected, that the violence is propagated no farther than the actual separation of continuity extends. In such cases, the parts divided will very frequently unite by the first intention. So indeed will many wounds, produced by mere laceration, especially in the common integument.

The passage of a spent ball along the cellular membrane, will often be united by the first intention, for the same rea-

son. For as there is comparatively no resistance, there will be no contusion, but only laceration.—But this is not often to be expected, where the shot has moved with great momentum.

The combination of contusion and laceration which takes place in Gun-shot wounds, Le Cat has called by the name of *attrition.* But I believe no single word will convey an adequate idea of it.

IV. ON HÆMORRHAGE.

When a sudden division is made in any part which is furnished with blood-vessels, it must necessarily be attended with an effusion of their contents. When blood flows only from the capillary vessels of a wounded part, the bleeding does not usually continue many minutes, and rather promotes than impedes its future reunion. But where an effusion of blood takes place from the larger branches of the arterial or venal system, or continues to flow even from the capillary vessels, so as to produce a derangement of the system at large, or an interruption to the ordinary progress of healing in the part, such a discharge of blood is denominated an hæmorrhage. Indeed the term may be applied to any bleeding that requires the assistance of art to suppress it.

It is not however usual for an hæmorrhage, properly so called, to take place

from the *capillary* vessels on the first infliction of a wound; or indeed at any period of its progress, except under very peculiar circumstances. These will be hereafter adverted to, as the nature of them will be better understood, when we have explained that hæmorrhage, which takes place in consequence of a wound made in any of the larger vessels.

Such an hæmorrhage may proceed either from an artery, or from a vein. If it proceed from an artery, the blood will be of a florid red colour; will flow from the vessel *per saltum*, its jet being synchronous with the diastole of the artery; and if it be restrained by pressure, that pressure must be applied on a part of the wounded vessel *nearer* to the heart than the wound in the vessel.

Hæmorrhage from a vein may be known by the flow of dark-coloured blood, issuing regularly, and capable of being restrained by the application of pressure

on that part of the vessel, which is *farther* from the heart than the wound in the vessel.

But as the veins are only supplied with blood through the arteries, pressure on an artery only may, on some occasions, stop the bleeding from a vein; but pressure on a vein only, will not stop the bleeding from an artery.

The most important hæmorrhages are those which proceed from wounded arteries; this order of vessels conveying the blood immediately from the heart; and therefore partaking more of the impulse of its contractions. The power of muscular action which they themselves possess, and the structure of their muscular coat, contribute also very often to keep on the hæmorrhage, and to prevent its effectual suppression. Hence a partial wound of an artery is sometimes more to be dreaded than a complete division of it. The violence committed in the division

of an artery, acts on the circular fibres of its musular coat, just as the same violence would do on the muscular fibres of any other part; namely, it stimulates them to contractions, which, being produced by an artificial stimulus, are often violent, convulsive, oscillatory, and irregular. If the artery be completely divided, these contractions often entirely shut up the orifice; and if they are strong enough to resist the impulse of the circulating blood, they prevent, or stop the hæmorrhage: and it is in this way that the bleeding from the capillary arteries is generally so soon at an end. But where the division is incomplete, these contractions must tend to enlarge the wound, and to keep up irritation on themselves, by twitching and vellicating the adjacent parts of the vessel. When an artery is completely divided, it also retracts longitudinally, and lies looser in the cellular membrane, and its coats will become somewhat corrugated near to the wound; but when it is only partially di-

vided, it remains still in a state of tension longitudinally, and thus keeps the wound open, and the injured fibres in that state of irritation, which keeping any wounded part upon the stretch, must necessarily produce.

No certain judgment can be formed *a priori* respecting the continuance of a bleeding, or the chance of its return, merely from the size of the injured vessels. For sometimes larger ones will contract and stop of themselves, while at other times smaller ones will bleed to a very alarming, and even fatal degree. But in arteries of the same size, *cæteris paribus*, those generally may be expected to bleed most freely, that are nearest the source of the circulation, or which branch off from their trunks at the smallest angle: because in these the impetus from the heart's action is least checked and interrupted.—Hence it is that bleedings from the arteries in the neck and trunk of the body, are often

much more profuse, and sometimes more suddenly fatal, than from arteries of equal diameter in the extremities.

From whatever vessels an hæmorrhage proceeds, its natural and immediate tendency is to produce languor, faintness, giddiness, diminished action in the blood-vessels, feebleness, and intermission of the pulse, coldness of the extreme parts, cold sweats, syncope, sometimes convulsions, and even death itself. And these effects of hæmorrhage come on with more certainty, and more rapidity, *cæteris paribus*, the more suddenly a quantity of blood is effused.

Beside these, which may be called the general effects of hæmorrhage, there are local ones, depending on the particular situation, functions, or circumstances of the part wounded; and others also more remote, both on the part, and on the system, on account of the debility induced by a large loss of the vital fluid.

Hæmorrhage may be suspended for a time, in consequence of the faintness it produces, which renders the action of the heart feeble, and insufficient to propel the blood with its accustomed force against the sides of the arteries. The diminution of the quantity of the blood may likewise be so great, as only to leave sufficient for a small dilation of the arteries, when it is thrown into them. Terror, external cold, the contused state of the vessel, extraneous substances, or coagula of blood pressing against the vessel, or lodged within its aperture, may all likewise occasion a temporary cessation of the bleeding, although no step is as yet commenced toward the repair of the injury: so that in such cases the hæmorrhage will probably return as soon as ever these causes cease to operate.

There are only three ways by which the bleeding from a wounded vessel can be permanently suppressed. The first is, causing the sides of the wound in the

vessel to unite by the first intention, without destroying the continuity of the canal. This can only succeed when the wound in the vessel is small, and made by incision, or puncture.—Such wounds in veins are very frequently healed in this way; as, for instance, those which are made in the common operation of phlebotomy. Under favourable circumstances, such a wound in an artery may also be healed in this manner; especially if the artery be a small one, and the impetus of the blood can be diverted for a sufficient length of time, from the point that has been injured.—The second is, by the sides of the vessel being brought, and preserved in contact, with sufficient firmness to resist the impulse of the circulating fluid.—And the third is, by the coagulation of the blood itself, or of its gluten, within the vessel, so as to obliterate its cavity at some part between the source of the circulation, and the orifice made by the wound. Every attempt made by art to suppress an

hæmorrhage, should therefore keep at least one of these objects in view.

The hæmorrhage, which is produced by gun-shot wounds, can only be suppressed in one or other of the two last mentioned ways. And of these, one, namely, causing the sides of the vessel to come into contact, can generally be effected by art with much more ease and certainty than the other, it being often feasible by means purely mechanical; whereas the coagulation of the blood within the vessel being a process for the most part depending on vitality, is much less under our command. In very few instances only can it be artificially produced; and in most of those in which it can, the coagulum must be afterward detached.

In many cases, as it has been already observed, the muscular fibres of a divided artery, contract spontaneously with sufficient strength to shut up the orifice;

and in others, they may be excited to do so by the application of remedies. But whether the sides of the vessel come into contact in this way, or by artificial force, an ulterior process, namely, that of union by adhesive inflammation, must take place between them, in order to render the suppression of the hæmorrhage permanent.

Hence we see, that though art can imitate the operations of nature in suppressing an hæmorrhage for a certain period, and can by so doing, bring the part into a favourable state for the lasting suppression of it, yet nature must, after all, do the work over again, in her own way, or the patient will be left in as bad a state as before.

As then the suppression of an hæmorrhage is effected by the formation and continuance of a resistance, superior to the momentum of the circulating fluid; if, by any circumstances, this momen-

tum is made superior to the resistance, or (which is the same thing in a mechanical, though a very different one in a pathological view) the resistance is so small, or becomes so lessened, that it is inferior to the momentum ; then the hæmorrhage must of course be reproduced. Hence plethora, fever, and other causes of a forcible impulse of the blood against the part, on the one hand ; and extreme debility, such as is sometimes induced by loss of blood, by distress of mind, by typhoid and pestilential contagion, &c. on the other, will be sufficient to occasion its recurrence ; sometimes even from the capillary vessels.

A part of a blood-vessel may be killed by the stroke of a shot, without being detached, and then hæmorrhage will come on at the exfoliation of the eschar, unless the vessel should, in the mean time, become obliterated.

A portion of a blood-vessel may also

be struck by a shot, and not killed, but yet so weakened as to be unable to stand the violence of a subsequent attack of inflammation, in which therefore it will die, and be exfoliated; and then a violent, and even fatal hæmorrhage, may be produced; of which the following is a remarkable instance.

J. B. was wounded August 27, 1799, by a musket ball, which was received under the clavicle, and after passing through the pectoral muscle, lodged in the axilla. The first symptoms were not very severe. In October the ball was discovered to have descended, and to be lying against the edge of the pectoral muscle, from whence I extracted it by an incision. Every thing went on perfectly well till the beginning of November, when he was attacked with rigors, which he attributed to cold. These were succeeded by a severe inflammation in the axilla, accompanied with much discharge from the former apertures. On the 19th

of November, some bits of cloth came away from the wound, and a little blood was discharged. In the night of the 21st, he was suddenly seized with a violent hæmorrhage, in consequence of which he died. On examining the parts after death, both the axillary artery and vein were found to have sloughed; a small piece having been detached from each, about the eighth of an inch in diameter. The remainder of both vessels was in a natural state, except some slight appearance of inflammation on their coats, near the part that was deficient.

Hæmorrhage sometimes takes place into the cellular membrane adjacent to the wound in the vessel, and sometimes into an internal cavity, from the want of a direct communication between the wound in the vessel, and that in the integument.—And this is a very common occurrence in gun-shot wounds, on account of the length and irregularity of their course.

The destruction of the principal artery supplying a limb, does not necessarily involve the destruction of the limb itself; although it will sometimes give rise to it. —There are many cases in which the anastomosing vessels have proved fully sufficient to carry on the nourishment of the part.

V. ON FRACTURE.

A Fracture is a sudden breach of continuity in a bone, produced by mechanical violence.

Every fracture is therefore to be considered as a wound made in a fractured bone, to the reunion of which all the circumstances are required which take place in the union of wounds of the soft parts; and in addition to them, a deposition of the phosphat of lime into the new formed substance, sufficient to render it equal in hardness to the original bone: a process which can only take place slowly, and which does not begin till the substance to be thus ossified is organized in other respects.

But as all bones serve more or less for the support of the parts in which they are situated, and often of other parts also; for the preservation of their form, and

the proper action of their muscles, a fracture of a bone is a disqualification of a peculiar kind, and demands the assistance of mechanical means, to remedy, for a time, the inconveniences it occasions; to preserve the bone in a state favourable to the reunion of the broken surfaces, and to prevent the muscles, directly or indirectly connected to the injured bone, from acting upon it, and especially upon that portion of it which is most moveable, and incapable of supporting itself; and also to prevent the fractured edges from rubbing against each other, and against the soft parts contiguous to them.

Perhaps, however, all that *mechanical* means can effect, in assisting the cure of a fracture, will be comprised in preserving the edges of the broken bone in exact contact, and preserving the whole of the bone in a proper direction. For though they may and do answer other purposes which are of a secondary nature, these are what must be always kept in view,

and are the principal tests by which the comparative value of different modes of securing fractured bones must be estimated.

When the fracture in a bone is totally secluded from exposure, by the integuments over it remaining entire, and the broken edges are kept in contact, the union generally goes on in a more favourable manner, and is accomplished in a shorter time. But when the fracture is exposed by an external wound, the inflammation following the accident generally exceeds the adhesive stage, the union is liable to much greater interruption and delay, abscesses and exfoliations are frequently occasioned, and both the part injured, the soft parts surrounding it, and the constitution at large, generally suffer in a much greater proportion. And all these evils will be increased, where, as is frequently the case in gun-shot wounds, the bone is much shattered, the soft parts around it much

torn and contused, the patient weakened by hæmorrhages, and his situation, at the time of the accident, unfavourable, both to the accurate reduction of the fracture, and to his repose and tranquility afterward.

VI. ON THE OPERATION OF EXTRANEOUS SUBSTANCES ON THE LIVING SOLID.

Every dead substance which is applied to a living one, is to be considered as extraneous; and as all dead substances are capable of producing some effect on the living substances to which they are applied, and as the lodgment of extraneous substances in gun-shot wounds, forms one of their most painful and troublesome features, it is necessary to point out those effects, and the principles by which their influence is regulated.

Extraneous substances may act either by their mechanical, or their chemical properties. The former only are connected with the present subject.

Some parts of the body are fitted, to a certain degree, to bear constantly the contact of extraneous substances without

inconvenience. And such parts of the body are, in all instances, *surfaces;* for no part in a natural state, is able to bear an extraneous body introduced *within its substance.* There is however great variety in the power of different surfaces to bear the contact of extraneous substances: and, indeed, when an extraneous body is lodged in the substance of a part by means of a wound, although it, in all cases, will be productive of some derangement in the living actions of that part, there is yet a great variety in the power of different parts to accommodate themselves to its influence. In the cellular membrane, for example, a bullet would be borne much easier, than in muscular flesh, or in a gland, or a bone, or even in adipose membrane.

But all extraneous substances, wherever they are lodged by force in a part, produce, by their contact, an excitement or irritation which is foreign to that part; and as the irritability, and generally the

sensibility also of the part, will soon be augmented beyond its natural degree, by the inflammation consequent on the wound, this irritation will in general be proportionably augmented by the presence of the extraneous substance; so that the inflammation itself, and all the consequences which that inflammation may produce, are likely to be exasperated: and in proportion as the extraneous substance has more of bulk, or of irregularity in its figure, or of pointedness or ruggedness of its surface, may the irritation it occasions be expected to be greater, more constant, and more lasting.

Extraneous substances, moreover, must always prevent the cohesion of the parts between which they are interposed. But this effect often conduces to procure their detachment; for as they prevent the union of the surfaces by the first intention, on the one hand, and irritate them on the other, they will necessarily suppurate, and secrete more pus than

would otherwise be produced. This discharge of the pus often carries them along with it; or where it cannot obtain an exit, produces an abscess, which brings the offending body within the reach of an instrument, by which it may be extracted.

But such are the powers with which the body is endowed, that often the most irritating substances, if they act only mechanically, by long continuance cease at length to irritate. The part becomes accustomed to their pressure; an insensible cyst is often formed round to enclose them; and thus nature, when unable to get rid of her foe, immures it, as it were, in a solitary cell, and takes away from it the power of hurting her any further.

VII. ON THE LAWS WHICH DETERMINE THE EFFECT OF BODIES IN MOTION.

The causes of several peculiarities attending gun-shot wounds, are to be sought among the laws by which moving bodies are governed; and by which the mechanical effect of a ball, propelled against any part of the body, must therefore be necessarily determined. The form, the momentum, and the direction of the shot that is received; the position, and the variety of structure, or, in other words, the variety of density and powers of resistance, in the part receiving it, must always be considered, in order to account satisfactorily for the effects it produces.

The first law which it seems necessary to call to mind on the present subject, is, that a body in motion striking against any substance, will communicate a part of its momentum to the substance against

which it strikes; and this communication will be in a direct ratio to the powers of resistance which that substance possesses at the time; whether such power of resistance be derived from its own density, or bulk, or force of cohesion, or momentum acting in a different direction. So that if the resistance be equal or superior to the momentum, the motion will be stopped; the momentum in this case being equally divided between the body impelled, and the body resisting: If it be inferior, it will only be lessened; and if at the same time it be inferior, and therefore incapable of stopping it, but yet act in a different direction, the future line of motion will also be changed, and it will fly off from the point at which it meets the resistance, in a line which will form an angle with that of the original direction in which it moved.

The resistance afforded by any substance to the motion of another, will be more or less, *cæteris paribus*, as the angle

of incidence approaches to, or recedes from a right angle; and if it be reflected, and the motion be continued in the same medium, the angle of reflection will always be equal to the angle of incidence.

The resistance which arises to a moving body from the density of any medium in which it moves, will be, *cæteris paribus*, as the surface of the moving body presented to that medium.

A dense medium forms a continued resistance to a body propelled with any given velocity; and therefore the more dense the medium, the greater the resistance; and of course the sooner will the original momentum be overcome by it.

A shot moving through any medium of uniform density, will also be acted on by the attraction of gravitation, so as to be continually changing the direction in which it moves; and if it move in vacuo,

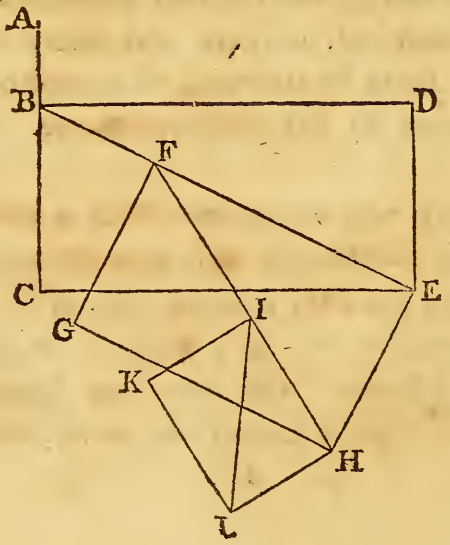
or in air, it will describe the curve called a parabola: but the commencement of this curve does not take place at the point from whence the gun-powder explodes; for within the barrel, and to some distance beyond it, the shot will move forward in a right line, called *The line of the impulse of fire;* (Vide Helsam. Lect. XI. p. 187.) which line will extend farthest horizontally, the less the angle of elevation of the piece recedes from an horizontal line.

The less of the original impulse is left in a shot still moving, the more liable will it be to be stopped, or turned out of its course, by any given resistance.

Every new resistance which a shot in motion meets with, will operate so as to produce not only a diminution of its momentum, but also a change in its direction. Every fresh resistance being in fact equivalent to a fresh power, acting

in a different line to that in which the shot was previously moving.

As a body acted on at once by two powers will not move in the direction of either, but in the diagonal of a parallelogram, of which two sides are formed by the direction and momentum given by each of those powers respectively, so every change of impulse, or resistance, will cause the body to move in so many changes of direction, till at length its momentum is overcome, and it becomes quiescent.



Suppose therefore any body, a shot for instance, represented by A, to be moved by a power with the velocity and in the direction A C to B, where it meets with a new impulse, with the momentum and direction B D, it will move in the line B E, the diagonal of the parallelogram B D C E.—Now, being acted upon by a new power or resistance F G, it will have its direction again changed, and will move in the line F H, the diagonal of the parallelogram F E G H; If at I another power or resistance I K, act upon it, it will move in the line I L, the diagonal of the parallelogram I H K L; and if it meet with no further power or resistance to change its direction again, will stop at L. But if it meet with any other power, or if any power still operating, upon it be subtracted, its direction will change accordingly.

A continued resistance from a dense medium, will therefore be a continued application of a power, the uniform and

equable operation of which will cause the motion to be curvilinear: The reason of which is sufficiently explained by writers on projectiles.

A shot, or other hard body falling upon a soft one; as, for example, on adipose membrane, or muscle, and stopping there, or lodging in it, still acts in conformity to the same general laws, and stops only from the resistance it meets with. If this resistance be afforded only by the force of cohesion in the adipose membrane or muscle, so much of that cohesion is overcome, as was equal to the momentum of the shot when it impinged against it; and therefore so far, and only so far, is its substance broken through, or destroyed.

Upon these principles only can the intricate and varied course and effect of balls, in parts of varied structure, consisting of substances differing in density and powers of resistance, be accounted

for and explained. And though in many cases a mathematical explication of the course of a ball cannot be given, this arises only from the want of data; the laws of matter being fixed and immutable. But where the data are known, as for instance, the velocity and direction of the shot, the position of the patient, or of the wounded part, when it was received, and the structure of the part or parts into which it was received, a much more probable conjecture of the course it has taken, may generally be formed, than if these circumstances had not been adverted to.

From what has been said, may be seen the reason of that concussion or shock, (*ebranlement*) which is given, in many instances, to the whole system, by the infliction of a gun-shot wound, and which has been remarked by the best writers on this subject, to be often attended with grave, and even alarming effects; extending not only over the injured part, but

affecting the system at large. For as the resistance to the shot, is afforded, not only by the texture of the injured part, but also is in part made up by the connection this has with other parts, and with the whole body, these also will therefore participate in the violence; and they will do it so much the more, in proportion as the part immediately wounded, has from its attachments, its texture, elasticity, or importance to life, a greater connection with the stability, or with the functions of the rest. Hence a shot striking against a tendon or a bone in one of the extremities, will produce a greater concussion than if it struck only against softer parts; a shot striking against a muscle in action, will produce more concussion than if it struck against the same part of the same muscle at rest; and a shot striking the head, or wounding the liver, lungs, or intestinal canal, will generally bring on an instantaneous derangement of the whole system, with which the functions of these parts are so closely connected.

To all this must be added, an alarm and apprehension which immediately come upon the mind, which is often increased by the uncertainty of the patient about his real state; but which, in wounds of some parts, the most determined courage is not always sufficient to withstand.

Having thus endeavoured to analyse the phænomena of a gun-shot wound, considering it first as a complicated species of violence committed on matter variously organized, and also to explain its effects as violence committed on *living* matter; and having pointed out the processes which naturally ensue from each of these circumstances respectively, in order to shew the indications of cure which may be deduced from them, I shall now proceed to point out by what mode of treatment those indications may be most rationally and successfully pursued.

PART II.

ON

THE TREATMENT OF GUN-SHOT WOUNDS.

THE treatment of gun-shot wounds may be comprehended under three distinct heads:—That which is called for by the state of the wound immediately on its being inflicted—That which is necessary during the inflammatory stage which is to follow—and that which may be required after the inflammation has subsided, and suppuration from the surface of the wound has taken place. Each of these I shall therefore now proceed to consider, after having first made a few general remarks on the examination of these wounds.

I. ON THE EXAMINATION OF GUN-SHOT WOUNDS.

When it is understood in what part of the body a gun-shot wound has been received, the Surgeon will naturally first examine where the ball has made its entrance; and next, whether it be lodged in any part, or if not, where it has made its exit. The orifice formed by its entrance, may in general be readily distinguished from that made by its exit, by being smaller, and more depressed. The reasons of this difference have been already assigned. The relative situation of these two apertures, and a knowledge of the parts which intervene betwixt them, especially if the position of the patient, with respect to his adversary, at the time the wound was received, can be known, and the laws of motion abovementioned be recollected, will sometimes enable the Surgeon to judge pretty correctly of the path the shot has made for itself, in passing from one point to the other. Where

a bone, or an important blood-vessel has been injured by it, the nature and extent of that injury will also require examination with the hand, or an instrument, or by an enlargement of the wound itself. But otherwise, where it is evident that the shot has passed out, and no particular circumstance demands the introduction of an instrument, it will often be better to do without it; at least till suppuration has come on. The introduction of an instrument being generally painful, and productive of additional irritation.

But where the ball, or any other extraneous substance has been lodged in the wounded part, and its situation is not immediately evident, it will often be adviseable to search for it at once, that it may, if its situation will admit, be extracted before inflammation begins. The Surgeon, therefore, considering all the circumstances which can assist him in forming a reasonable conjecture of the

course of the wound, will give to a strong probe that curvature, or form, which he thinks most likely to pass readily along it, and will proceed to make his examination. But where this is very painful, and the course of the wound very doubtful, or obscure, it will often be better to desist: for an unsuccessful examination must irritate the part, and will therefore do harm.—Afterward, when suppuration has taken place, the search may be made with more ease, and with a greater prospect of success.

If inflammation have already commenced, it will be still more difficult to make a successful examination, and more hurtful to make an unsuccessful one. The tumefaction of the parietes of the wound making its canal less, while the injured parts become more rigid, swelled, painful, and unequal; and thus present greater obstacles to the search, in addition to the irregularity in the course of the wound itself.

There are other circumstances, however, beside those already enumerated, which may absolutely require an immediate attempt to obtain certain information of the course and extent of a wound. As for instance, it may be desirable to know whether an internal cavity be penetrated; in what particular point a blood-vessel has been divided; whether a viscus, or other important part which has been in the way of the ball, be actually wounded, or not; in order to determine from thence of the position and subsequent treatment which are to be preferred. Therefore it is of great importance to conduct the examination so, as to be sure of the most certain possible information, and to be least liable to deception. For this purpose the position of the wounded part must be studied, that it may neither be put too much upon the stretch, nor, on the other hand, corrugated by too relaxed a position; lest the instrument employed should, from one or other of these causes, get entangled in its passage.

There is great advantage in employing the finger, when it can be done, in preference to any instrument whatever.—Great disadvantage often arises from instruments that are too flexible, or have a small point, as they are liable to get entangled in cellular membrane, or some lacerated fibres, and thus to communicate deceitful sensations. Hence a sound is sometimes preferable to a probe. If a probe be used, it should be a strong one. A flexible catheter, furnished with a very stiff stilette, the curve of which can be varied occasionally, and which when covered by the catheter, will be larger than a probe, will sometimes be useful. A bougie is commonly a bad instrument for the purpose, as it will not retain the curvature given to it, and thus becomes a very uncertain guide, and puts the patient to useless and unnecessary pain.

The constitutional symptoms which supervene from the concussion produced by the shot, from the alarm or uncertainty

of the patient's mind, from the pain, or the hæmorrhage, will not escape the Surgeon's notice, on the first examination of his patient. These may perhaps, in some measure, subside of themselves, if the Surgeon can give a consolatory opinion respecting the state of the wound; or may be relieved by the exhibition of a suitable cordial; as wine, brandy, volatile alcali in water, or camphor julep, to which opium may sometimes be added with advantage.

When the state of a wound has been ascertained by examination, the immediate treatment required, will probably be either from the hæmorrhage, the extraneous substances lodged in the wound, the state of the bone, the peculiar office or situation of some wounded part, or it will be that only which is called for by the nature of this kind of violence, simply considered. Each of these circumstances shall now be adverted to.

II. ON THE TREATMENT OF HÆMORHAGE FROM GUN-SHOT WOUNDS.

It is not usual for gun-shot wounds to bleed freely at first, unless some considerable vessel be injured. So that this may be suspected whenever much blood is effused, and will then be the first circumstance to command the attention of the Surgeon.

The application of a tourniquet, or where a tourniquet cannot be used, of pressure, if possible, by some other means, to the artery from whence the blood is derived to the wound, is a measure of the most immediate and absolute necessity; both in order to prevent the patient from immediately bleeding to excess, and likewise to give time and opportunity for a calm and proper examination of the circumstances of the wound.

Where a tourniquet cannot be applied,

or is not at hand, lint, or some other substance, may be introduced into the wound, to press against the bleeding orifices, and should be secured by a very tight bandage. But if circumstances admit of it, it will be best to proceed at once to such an examination of the wound, as may ascertain what vessels are actually wounded, and at what precise part the wound has penetrated into them: and if an incision be required to make this examination satisfactorily, it must be made without hesitation.

When it is ascertained that the bleeding proceeds from an accessible vessel, the suppression of it must be at once attempted, either by passing a ligature round the vessel, or by compressing its sides together, or by the application of something that can promote the contraction of the muscular coat of the arteries, or favour the coagulation of the blood within them.

Of all these modes of suppressing hæmorrhage, that by ligature is the most certain; and in every case, where it can be employed, and where the wounded vessel is an important one, it is undoubtedly to be preferred. Nor is there any blood-vessel that lies within reach so large or important, but that a ligature both may, and ought to be passed round it, if it happen to be wounded.

In order to do this with certainty and effect, it will often be necessary at first boldly to make such an enlargement of the wound by incision, as will bring the wounded part of the vessel fairly into view, and as much as possible under the command of the needle. This is generally far safer and better, and often gives much less pain, than poking into a narrow and inadequate aperture, or making a random plunge, which may include parts that had better be avoided; and perhaps even miss the vessel it was intended to

secure, or render the hold of the ligature uncertain and insufficient.

In wounded arteries it will sometimes be necessary to pass two ligatures, one above, and the other below the wound, on account of the communication of the anastomosing vessels; which, in some cases, would be otherwise sufficient to keep up the hæmorrhage, especially from large arteries. Where an artery is not completely divided, it will often be better, after the ligatures are secured, to cut the vessel between them entirely through, in order to allow it to retract longitudinally. But the ligatures should not be passed close to the cut edges of the vessel, for fear of their slipping, or being driven off by the impetus of the blood. Nor should the vessel be too nicely stripped of the cellular membrane, &c. immediately attached to it; from which its coats often receive the minute vessels by which they are nourished, and which they would then be deprived of, so as probably to

die, and slough; or at least to be left incapable of performing those operations within the vessel itself, by which alone the hæmorrhage can be lastingly suppressed. Nerves must not be included in a ligature, if they can be readily avoided. But I know, from experience, that the principal vein of a limb may be included in the same ligature as the artery, without any disadvantage ensuing from that circumstance. Indeed I am inclined to believe it is better to tie any thing, than totally to strip and denude a large artery much beyond the ligature with which it is tied. And on this account very large arteries, as the brachial, and femoral, for example, should not be drawn out naked by a tenaculum, and tied in that state, when a needle can conveniently be used.

In the choice of ligatures, care must be taken not to have them so small as to run the risk of cutting the vessel; nor so thick, or stiff, as will render it difficult to tie a firm, and impervious knot.

Although a ligature may be well secured, yet if it be passed round a large artery, it will generally be prudent, in binding up the wound afterward, to place a longitudinal compress along the course of the vessel, above the ligature, in order to make a gentle pressure upon it, which may moderate the impetus of the blood, before it reaches the seat of the ligature: taking care, however, not to bind it so tight as to obstruct the communication with the anastomosing branches above and below.

But as some vessels are so situated as not to admit of a ligature being passed round them; and as a ligature is in all cases an extraneous substance, the presence of which must more or less irritate and inflame, it is often desirable to dispense with its use, and to have recourse to other means for suppressing an hæmorrhage.

Next to the ligature, the most effec-

tual mode of stopping an hæmorrhage, is by the application of pressure against the vessel, sufficient to force its sides into contact, and so to retain them till the orifice is obliterated: which is the precise object to be kept continually in view, in every application of pressure for this purpose.

It follows, therefore, that an exact determination of the pressure required, *to the injured vessel,* is of the utmost importance: since it can signify little or nothing, how tight, or how firm, or how neatly it is made in other respects, if after all, the sides of that identical vessel are not held close together, with a strength superior to that of the impulse of the blood.

This shows the necessity and advantage of having recourse to graduated compresses; especially when it is a single vessel, or the branches from any single vessel, within their command, that is

bleeding. A small thick compress, of a proper length, and about three or four times as large in its diameter as the vessel, being first exactly applied, and secured in its precise situation, with another rather larger over it, and another still larger over that, and so on, all fixed by adhesive plaister, or a bandage, or both, will not only most effectually stop the beeding, but will interfere least of all with the circulation through the anastomosing branches; which it is often extremely desirable to preserve uninterrupted, and which would be greatly impeded by a pressure made equally on every part of a limb, by the application of a very tight bandage alone.

In a large wound, where many vessels are bleeding, the principal attention should be directed to the trunk or trunks, from which they derive their most direct and immediate supply. Where this is insufficient, or where the trunk cannot be compressed, an equable and uniform

pressure may be made to surround the part, and must in some cases be made by compresses applied to the wounded surface itself.

But it is always an advantage, where it can be done, to apply the compresses in contact with an uninjured surface, which shall nevertheless command the bleeding, by interrupting the supply of the blood. For there the compressing substance will give less irritation, will be less liable to be moistened and loosened by the oozing of the fluids from the sore, and will less disturb the natural processes of healing in the part.

In many cases, such for example, as wounds of the temporal and radial arteries, this can easily be done; but in deep and narrow wounds, such as are frequently made by gun-shot, it is often impracticable; as for instance, in a wound of either of the arteries of the leg, made by a shot passing between the heads of

the Tibia and Fibula. Yet here the plan of graduated compression may be employed with advantage. A small bit of sponge, or a small dossil of lint, being passed down to the bleeding vessel with care and precision, may be followed by another, and this by another, and so on, till an adequate degree of compression is produced, that can be maintained by a bandage over all. The great point being to make the first bit or two small and firm enough to pass with ease and certainty to the bottom, and actually to press against the orifice, or rather against the sides, of the artery from whence the hæmorrhage proceeds; and then the rest will act by pressing upon the first.

The substance made choice of to effect the compression in such cases, should be that which is least likely to slip. And where it must be so situated as to be moistened with the fluids of the part, it will be an advantage to let the substance immediately pressing against the vessel,

be one that will either increase in bulk, or elasticity, or both, by becoming so moistened. Hence sponge is highly useful for such purposes, and if it be first properly prepared, is often preferable to lint. And perhaps the once famed Agaric of the Oak, *(Boletus igniarius)* owes more of its credit to this circumstance, than to any of its medicinal properties.

When neither compression nor ligature can be employed, our resources lie in having recourse to such remedies as are found to promote the contraction of the vessels themselves, or the coagulation of the blood within them.

To attempt either of these with advantage, the impetus of the blood must generally be reduced below the natural standard; either by the hæmorrhage itself, or by a bleeding purposely instituted, or by some other means: such, for example, as the application of cold. The

active powers of the arteries themselves being thus weakened, and the quantity of blood diminished, a less resistance will be sufficient to withstand its impulse against the divided part.

The coagulation of the blood within the vessels themselves will be peculiarly favoured by this procedure. For in order that the blood may coagulate in them, it must rest there for a short time; which it cannot easily do, unless the *vis a tergo* is somehow diminished; and when this is diminished, it will often coagulate naturally, and the bleeding will stop. A circumstance to which those farragos of trumpery and imposition, that have been imposed upon the world under the appellation of Styptics, and which never appear to do good except when they are resorted to at this period, are more than any thing indebted for their credit.

When an artery is only partially divided, it may sometimes be excited to con-

traction by cutting it completely through: especially when the wound in it is situated in a part, where its contraction is mechanically impeded by its attachments. As in the case of an artery running in a furrow or canal of bone. If the vessel be cut through before it enters that furrow or canal, and where of course it lies looser, it will probably contract, and the bleeding will cease. In this way a bleeding from the medullary artery of the Tibia, for instance, and from others similarly circumstanced, may often be stopped.

The bleeding from arteries running IN BONE may often be most effectually stopped by a judicious application of the actual cautery; which both coagulates the solids and fluids it touches. The subsequent inflammation, by which the eschar is detached, will generally be sufficient to obliterate the orifice in the vessel.

For the rest, the most effectual remedy

for exciting the arteries to contraction, is, I believe, the Oil of Turpentine. Next to this is cold; which should be repeatedly applied, by means of water, or the vegetable or mineral acids diluted with water, so as to keep the part constantly under its influence, and to diminish its temperature, till the obliteration of the wounded vessel has made sufficient progress, to be trusted to such a degree of pressure as the circumstances of the part will permit it to bear.

Alcohol, the Sulphats of Alumine, Copper, and Zinc, the astringent Resins, Nitrat of Silver, the mineral acids, Caustic Alcali, &c. may sometimes be applied with advantage, either pure, or in combination with water. Agaric, Galls, and other astringent vegetables, are also occasionally useful.

Beside these, Moxa, Cobwebs, Styptics, Charms, and Conjurations innumerable, have obtained a temporary credit;

the honour of which may be equally divided between those who recommend them, and those who employ them.

It must, however, be observed, that as an hæmorrhage may be kept up, or reproduced, by such a degree of debility as takes away from the muscular fibres of the arteries the power of contracting with sufficient force, some caution must be used with regard to the evacuation of blood, which is one thing capable of producing such a debility. But in wounds of the viscera, all the risk arising from copious and repeated bleedings must be hazarded for a time, to render the circulation in the part very feeble, till the obliteration of the vessels first injured may be concluded to have taken place, and to be in a good degree consolidated: For in this way only can the patient be saved; the situation of those parts admitting of no external applications immediately to them. This is above all the case in wounds of the lungs. Nothing is more

essential to the stoppage of an hæmorrhage, and counteracting the inflammation which is to follow, than keeping the wounded part at rest: And therefore the lungs, when they are wounded, must be kept as much as possible at rest, by diminishing the quantity of blood, the whole of which it is their indispensable duty to transmit, before it can go the round of the circulation by the branches of the Aorta.

When the quantity of blood has been much reduced by an hæmorrhage, the circulation is for a time not only feeble but slow: the pulse being infrequent, and sometimes irregular. And if by any exertions, as in moving the patient, or even overcharging his stomach with nourishment, the heart should be too suddenly excited to more frequent contractions, the supply of blood will often be found unequal to its efforts, and the patient will in consequence die. Hence it is always proper on such occasions to

keep the patient as much as possible at rest; and even sometimes not to move him from the very spot on which he lies, until by means of light nourishment, slowly conveyed, in small quantities, and at regular intervals, time has been given for the formation of more blood, and the arterial system has been suffered to contract sufficiently, to accommodate itself to the diminished quantity of its contents.

And then, in order to prevent the hæmorrhage from returning, the continuance of a spare and cautious diet, the occasional use of gentle aperients, neutral salts, acids, and occasional doses of opium are to be employed. The patient must live in a cool atmosphere, not exceeding 55°. of Fahrenheit's Thermometer; must not be heated by an accumulation of clothing, and must preserve a state of constant quiet, with an easy position of the part. But if the hæmorrhage should be continued under symp-

toms of great general debility, the internal exhibition of bark, with aromatics, or with the mineral acids, may be advisable, and a more cordial and nutritious diet allowed. The mineral tonics, particularly the preparations of Iron, Zinc, and Lead, will sometimes have the best effects; and the internal exhibition of the Oil of Turpentine, in doses of eight, ten, or fifteen drops, three or four times a day, will often prove superior to any other medicine.—At the same time, the local treatment by ligature, compression, &c. described as proper in the primary hæmorrhage, must be adopted, as far as circumstances will admit of its being employed with any prospect of advantage.

But notwithstanding all our efforts, the effects of a large and repeated hæmorrhage cannot in all cases be overcome. Sometimes death, or some incurable debility will follow; and sometimes aneurismal tumours will arise, from the im-

perfection with which the healing processes in the arteries are performed. And in some cases, foreseeing what another hæmorrhage will produce, and the probability of its occurrence, we are under the necessity of performing the amputation of a wounded limb to prevent it. But this, with other circumstances calling for so severe a determination, must be made the subject of a separate Chapter.

III. ON THE TREATMENT REQUIRED BY THE LODGMENT OF EXTRANEOUS SUBSTANCES IN THE WOUND.

The extraneous substances that may be lodged in wounds by means of Gun-shot, are of considerable variety: For not only may the shot itself enter, and remain, but it may carry along with it pieces of cloth-ing, buttons, or any thing else which lies in its way. Generally speaking, leaden bullets are as little hurtful as any sub-stance whatever that can be introduced in this way, except they become altered in their shape by striking against bone, or any other hard substance, capable of producing a change in their form, or on some part of their surface.

The irritation, however, that all extra-neous bodies occasion by their presence, and the tendency they have to increase, continue, and renew inflammation in the wounded part, makes it always a desir-

able thing to extract them, as soon as it can be done without sacrificing more essential considerations. And therefore, whenever they are readily accessible, either through the wound, or by a counter-opening, unless any particular objections occur from the degree of hæmorrhage that has already taken place, or some considerable local obstacles to their extraction, their removal should be accomplished immediately. When their extraction is attempted to be made through the wound, it will generally require enlarging, in order to effect it with facility: For nothing is more injudicious than stretching and tearing open a wound by instruments, for this purpose; particularly as their bad effects will be increased by any irregularity in the substance itself. *Ne quid nimis*—But in most cases of this kind, it will be less hurtful to cut too much, than to poke too much.

Cases may however occur, in which,

even when it is clear where the ball is lodged, and that it cannot be extracted without an enlargement of the wound, an incision must not be made: as in the following instance.

A man was wounded in the left cheek by a shot, which struck against the Os Jugale, and then, passing downwards, lodged between the parotid gland, and the Masseter muscle. An incision sufficient to allow of its extraction, must have divided those branches of the *portio dura* of the auditory nerve, which form the *pes anserinus*, and have rendered that side of the mouth paralytic. After suppuration had taken place, and the irritation had subsided, the wound was readily dilated with sponge tent, and the ball, which had become ragged from striking against the bone, was readily extracted by a pair of curved forceps.

On the whole, I think the following rules will safely guide the practitioner in

his attempts to extract shot, and other extraneous bodies.

First, It should be clear where they are lodged.

Secondly, It should be probable that there will be no greater risk in the extraction; and all that is necessary to it, than will arise from the continuance of the substance itself.

Thirdly, If a state of high inflammation be present, unless it be probable that it depends as much or more on the extraneous substance, than on the wounded state of the parts, the extraction had better be postponed till suppuration comes on.

But where tetanus, or convulsions supervene, an extraneous substance should be extracted at all events, if it be any way accessible without imminent danger.

But as a ball, and even substances

much more irritating, may be sometimes undiscoverable, and are sometimes out of the reach of an instrument, and must therefore be let alone; if the part and the constitution can be kept in a state the least likely to feel their irritation, for a sufficient length of time, they may at length become inclosed in a cyst, and produce no farther inconvenience. The treatment by which this may be promoted, will be considered with that of the inflammatory stage.

The bullet forceps I first described in the 40th number of the Medical and Physical Journal, and which are now sent out in all our army instrument chests, appear to me preferable to any other instrument for the extraction of balls, and other extraneous bodies. An engraving representing them will be found at the end of this treatise.

IV. ON WOUNDED BONES.

The injuries which may be produced by a shot striking against a bone, are manifold; both as they respect the bone itself, and the parts immediately attached to it.

A shot may strike against a bone without effecting any breach in its substance, and yet denude it for a considerable distance; especially if it strike against it very obliquely; in which case it will pass along it to a greater or less extent, tearing whatever comes in its way, till its force be expended. Thus I have known a shot enter the lower part of the inside of the thigh, strike against the bone, and make a spiral curve in its passage along and around it, which terminated nearly at the top; comprehending therefore almost the whole length of the bone in one circumvolution, and tearing away in its passage the greater part of the muscles

from the Linea Aspera. In such a case indeed the principal violence is that done to the soft parts; and no peculiar treatment would be called for, except that a free dilatation of the wound from its orifice, down to the bone, would soon become requisite; or if the ball should have entered above, and passed downwards, and can be distinguished, an opening below of the same kind must be made, which should be kept in a depending position; and should be made large enough at first to open and preserve a sufficient drain, without the necessity of cramming in lint to make it wider. Then little splinters, or subsequent exfoliations, will be more easily removed, and sloughs, blood, pus, &c. will find an easy and expeditious discharge.

When a shot lodges in the substance of a bone without fracturing it, it will not in general be easy to extract it, till suppuration comes on, and the parts have got into a quiet state, unless it lie very

superficially. When the state of the parts will admit of its extraction, the sooner it is done the better, as otherwise the bone will shoot out osseous granulations around it. The application of a trephine, or a saw, will sometimes be necessary to get readily at it. The forceps above mentioned, have in these cases peculiar advantages, as I have several times experienced.

When a shot passes with great velocity, and the patient is near to his antagonist, it may go clear th ough the bone, without breaking it completely across, so as to destroy its continuity; particularly if it strike a flat bone, or the thick part of a cylindrical one, as the condyles of the Femur, or Tibia, for example. Or, which is nearly the same thing, it may go through a part, or the side of a bone only, so as to make a notch in it. Such wounds will most probably require early dilatation, and the removal of any splinters of bone that may be loosened;

although these will generally be most easily detached when suppuration is established.

A wound in which a bone is completely fractured, is to be considered in all respects as a compound fracture, and to be treated accordingly. In all salvable cases, the other circumstances of the wound being attended to, the bones must be placed in as natural a line as possible, and supported in it by suitable bandages, compresses, and splints or junks. And if the bone be not shattered to a great extent, or if the injury to the soft parts be not very considerable, all may notwithstanding do well. Indeed, in most cases of this kind, the prognosis is to be formed as much or more from the state of the soft parts, than from that of the bone itself; which will often recover very great injuries, if the surrounding soft parts are in a tolerable state.

So much therefore depends on the ma-

nagement of the soft parts in these cases, and on removing, as far as is possible, whatever is likely hereafter to excite or keep up additional irritation in them, that whenever splinters of bone are beaten into them, they should be, if possible, immediately removed, and the wound enlarged sufficiently if it be requisite, and if the nature of the adjoining parts will permit, to allow of its being done with facility, and without producing fresh laceration. Indeed, in all such cases, splinters of bone should be removed if they are perfectly detached, or so far loosened from their connection with the surrounding parts, that it is evident they cannot reunite with them, and they can at the same time be extracted without violence. And this should be done before the fracture is bound up, or the patient removed; as by this mean, both the pain and the danger of removing him will be diminished. But where they cannot be extracted without violence, or where the extraction of them is forbidden by the

risk to which contiguous nerves, or blood-vessels must be exposed, it is necessary to wait till suppuration comes on, and the parts are more at liberty, and then to proceed according to circumstances.

A bone broken by gun-shot will often be split longitudinally, or splintered, above the apparent seat of the wound; and sometimes the broken ends will be greatly displaced, being driven away from each other by the force of the shot, and wedged, as it were, in that situation, so as not always to be capable of reduction. And yet, if the principal injury be confined to the bone, such cases may recover. Sometimes a projecting piece of bone may be removed; sometimes ossific matter will be thrown out, so as to fill up a part of the gap which is formed; and this, with the exfoliation of some pieces, and the power nature has to remove the asperities of projecting points and edges by her own operations, will often at last make the bone, when united,

more level than could at first be expected.—So that the Surgeon must balance all the chances in his mind, before he determines on the removal of a limb in such an instance; and he must especially take into his account the accommodations of the patient. As many cases may recover, if assistance be at hand, and a lodging or an hospital near, which the situation of a pursuing or retreating army, and other circumstances making it necessary to move the patient to a great distance, will render absolutely incurable: especially if it be the lower extremity that is injured.

Wounds of joints are subject to the same rules as wounded bones. For joints are bones, and their appendages, surrounded by soft parts. And where a shot lodges in a joint, and can readily be got at, or injures it so as to splinter the bones, the wound may be dilated, and must be treated according to the same rules as in other parts. The principal

danger in these cases arises from the subsequent symptoms, which are always much exasperated by the unyielding nature of capsular ligaments, and the close contact of the nerves and blood-vessels passing over them. These we shall presently consider. In many cases indeed amputation will be requisite, and the causes which call for its performance on the spot, shall next be attended to.

I cannot however quit this subject without observing, that splints made of tin, after the pattern of Mr. Sharp's pasteboard splints, and covered with soft cloths, will be found extremely convenient in removing fractured limbs, as well as in supporting them afterward.

V. ON GUN-SHOT WOUNDS WHICH REQUIRE IMMEDIATE AMPUTATION.

The amputation of a limb is a violent act, and never to be performed but for the purpose of preventing or removing a greater evil: That is to say, an evil by which, upon the whole, the life or subsequent comfort of the patient must be more endangered. When amputation is performed for the removal of an evil actually existing, and the nature and consequences of which are known, the indications are often much more clear and satisfactory, both to the patient and the Surgeon, than when it is performed to prevent the supervention of such an evil. So that in the latter case, more caution is frequently requisite, and many circumstances must be taken into the account, before the propriety of it can be absolutely concluded.

It is well known that M. Bilguer, Sur-

geon General to the late King of Prussia, wrote a book on purpose to condemn this operation *in toto;* and that his opinions had so much influence over his Sovereign, as to occasion an edict, by which it was absolutely forbidden in military practice. And although we should now justly look upon such a law as absurd, this is a good deal owing to the improvements which have been made since his time in the operation itself. For if amputation now, were the same thing as it was then, the continuance of such a law, however hardly it might operate in some cases, would still have a very colourable excuse. The mode of amputating at that time by single incision, the dressing the whole surface of the stump, and making it suppurate, the fever induced by these means, the length of time such a stump took to heal, the uncertainty of its healing at all, and the extreme tenderness of the cicatrix if it did, must make the chance of recovery it afforded, to be

scarcely worth the sufferings by which it was purchased.

The present improvement of the operation by the double incision, and covering the stump with skin, the frequent union of this by the first intention, and the consequent diminution of all the risk, place the question of amputation in a very different point of view; and justify our having recourse to it in many cases, which would formerly have better been left to themselves.

But still amputation does not cease to be a serious evil. It is an operation, which if it does not diminish, must certainly increase the patient's danger; especially when it is performed on a sudden occasion: because it superadds an act of violence to one already committed, to which the constitution has had no time to accommodate itself, and which, by the very operation it calls for, has al-

ready brought the life, or well-being of the patient, into danger.

It will not therefore be too much to assert, that where the nature of a wound, or the circumstances under which it is inflicted, are such as to leave the necessity for it doubtful, it had, in most instances, better be delayed. And the cases recorded by Mr. Bilguer, as well as many others in which the operation has been omitted, through the obstinacy of the patient, the want of timely assistance, or the wiser and more patient conduct of modern Surgery, have been sufficient to show how great are often the resources of nature, and how much she has been libelled, in what were once considered as some of the rules of our art.

It cannot be denied that the state of the patient's mind, and often of his body, at the moment a Gun-shot wound is inflicted, are generally the very worst that could possibly exist for so severe an

operation; and that it is in no small degree owing to this, that a great proportion of those on whom it is immediately performed, do nevertheless die.

Yet, notwithstanding all these grave, and very serious considerations, it must sometimes, nay it must often be done. Sometimes the state of the wound, sometimes the state of the patient, and sometimes surrounding circumstances, leave him no other than the melancholy alternative, of amputation or a miserable death.

And indeed amputation, though it makes a large, and often a very formidable wound, yet as it makes that wound only by simple incision, and capable therefore of healing by the first intention through a great part of its extent; and as it is thus able, in many instances, at once to remove a source of certain danger, violent irritation, and otherwise irremediable pain; the performance of it may

in many cases be instantly resolved on, not only without a diminution, but with a great increase of the probability of an ultimate, and often of an easy, and speedy recovery.

When, for instance, the lower portion of an extremity has been entirely shot off, there can be no doubt of the propriety of immediately performing the operation of amputation, to remove the shattered end of what remains; and thus to reduce a contused, lacerated, irregular, and debilitated wound, to one made by simple incision, in a part otherwise uninjured and healthy, where nature will of course have less to do, less to encounter, and less to fear.

Nor will the necessity for the operation be less imperious and decisive, where although the limb be not actually carried away, it is so injured, that the parts below the wound are deprived of life; or every thing necessary to the utility of

the limb is destroyed. For then there is not only a wound of the same magnitude and nature as in the former instance, but in addition to this, the useless and pernicious incumbrance of a mass, which must presently die, and which nature must have herself to remove, if the Surgeon does not save her from that dangerous task by a timely operation. The death of any considerable part of the body, though in itself unimportant to the rest, can never take place without producing a very material derangement of the vital functions. Indeed often, when only a small part mortifies,

"Life feels the wound, and Nature from her seat,
"Sighing through all her works, gives signs of woe."

So that wherever there is a certainty, or indeed a very great probability, that this will take place in so great a part of the substance of the limb, below or around the wound, although it be not yet actually destroyed, that the disorder excited in the system will be too great to enable the

patient to get over the full establishment of suppuration, either owing to the extent of the mischief, the state of the patient, or the necessity of moving him immediately to a great distance, amputation must also be immediately performed. But where, on the other hand, there is a probability that the period of suppuration may pass over, without any fatal inroads upon the powers of life, it will be better to wait; as a better idea may be afterward formed of the patient's chance of recovery; and the limb can still be removed, if the constitution shall show itself, after an adequate trial, to be less capable of repairing the injury which remains, than that which would subsist after amputation is performed.

In order to estimate these circumstances, it must be considered, that where a part, though grievously wounded, still retains its principal nerves and blood-vessels entire, it is furnished with the grand requisites to its restoration. And there-

fore if the nervous and arterial systems be healthy, it may still be salvable; or at least in such a state, that the patient is very unlikely to be benefited by an immediate amputation.

But where the principal nerves and blood-vessels, or indeed where the principal blood-vessels only are shot through, or destroyed, the rest of the injury must be comparatively slight, to leave a reasonable hope of the salvation of the limb. For in such a case, the circulation can only be carried on by the anastomosing vessels, which are in some instances scarcely equal perfectly to maintain even the ordinary circulation; and must be still less so to carry it on when augmented by the inflammation of a severe wound, and the additional task of restoring parts that have been destroyed; especially where this increase of duty begins suddenly, as in the case now supposed, and no time has been given, like that which is obtained in some cases of aneurism,

for the anastomosing vessels to enlarge, and increase their diameter and muscular powers, before the final obliteration of the principal artery.

But where the mischief is not in other respects great, the destruction even of the principal artery of the limb, is not of itself a sufficient reason for amputation. Much less is it allowable to amputate on account of a wound in a branch of the principal artery, provided it be so situated, that it can be secured by a ligature, or adequate compression, or have spontaneously ceased to bleed. By a principal artery, I mean what the brachial artery is to the upper extremity, or the femoral artery to the lower. The ulnar and radial arteries of the fore-arm, and the anterior and posterior tibials of the leg, are only to be considered as branches. For the destruction of the radial would be fully compensated by the integrity of the ulnar, or that of the anterior by that of the posterior tibial, and *vice versâ*.

Where the bone is very much shattered, it has been recommended to perform immediate amputation; especially if the wound enter the joint; and where the injury to the soft parts is also extensive, it will generally be best to do it. Yet if the vessels and nerves have escaped, it may not always be necessary. But the wound must be freely dilated, and all extraneous substances, and loose splinters of bone must be extracted, to afford a reasonable hope of saving the limb. These are the cases which most of all call for the deliberation, and discretion of the Surgeon; and in which much, very much, will hinge upon the particular circumstances of the case, and the situation and condition of the patient.—I will here insert the two following cases. The first, because it will show how much injury a bone may endure without the destruction of the limb; and the second, because of the strong impression it made on my own mind, of the necessity of sometimes boldly enlarging wounds entering joints, and

the safety which would probably in many cases attend it.

Case I.—G. W. was wounded Oct. 2, 1799, by a ball which entered the upper and outer part of the right arm, and splintered the Os Brachii, which was broken off about two inches below its head. The shot passed inward, and lodged under the integument about three inches lower down, from whence it was extracted by an incision. The pain which followed for some time was intolerable, and could not be quieted by large doses of opium. I saw him first on the 29th of November, and found the bone bare to a considerable extent, and a large portion of it loose; which I extracted the following day. It was eight inches and an half in length, and for three inches and an half it apparently contained the whole substance of the bone; from thence it gradually tapered off. The upper part of the arm being thus destitute of bone, was easily bent in any direction. The

surrounding soft parts, however, were much thickened, and bony matter was evidently growing up from below. The following day several more splinters were extracted. He became easy, and improved rapidly in his health. On the 2d of January following I found the bone had united, and he was able to leave off wearing splints; and by the end of February the wound was perfectly healed. The arm was two inches shorter than the other; but he retained the use of the shoulder joint, limited only by the state of the muscles, and the rigidity remaining after so much inflammation.

Case II.—J. T. aged 19, was wounded Aug. 27, 1799, by a musket-shot, which entered the left knee, splitting the external Condyle of the Femur. The ball was lost in the joint. Great irritation followed, with suppurations in and around it, and very considerable enlargement. In this state I saw him on the 21st of September. On the 1st of October, feeling

a portion of the bone loose, I enlarged the wound a little, and extracted it, and on the 5th a still larger piece was removed, amounting together to almost the whole of the Condyle. No relief followed, and on the 10th amputation was resolved on; but as he fainted away on moving him for that purpose, the operation was abandoned, and in a few days he died. On examining the limb after death, I was astonished to find how very confined the real organic mischief had been, scarcely extending in any part beyond the ligament of the joint. I found the ball lodged in the internal Condyle of the Femur; but so that it might have been discovered and extracted, had the opening in the joint been made large enough for a free examination; though by repeated search before I could not discover it. I now think the symptoms in this case would have justified a bold incision; which must have done much less harm to the joint than the ravages of the inflammation excited by the ball, and

would have afforded the patient a very probable chance of recovery.—If a joint be already opened by the shot, enlarging the opening it has made by the knife, and thus giving room for a perfect examination, and a ready exit to whatever should come away, will be perfectly justifiable, and may preclude the necessity of amputation.* In the case now related,

* The following interesting Case has been lately communicated to me by Mr. Stewart, Surgeon, of Bourn, in Lincolnshire, and affords a striking instance of the utility that may result from adopting this practice on proper occasions.

" T. W. of Pointon, in the county of Lincoln, received a punctured wound in the knee joint from the point of a reaping hook. The Surgeon, who had the care of him, employed repeated bleeding, purging medicines, hot fomentations, poultices, and every plan of reduction. He passed ten days under this plan before I saw him; at which time his pain was extremely increased, the whole limb distended with lymph, the knee exquisitely painful when touched, and wonderfully enlarged; a small wound, surrounded with pale, pouting edges of granulations; pulse low, great

it is however to be observed, the vessels, nerves, and principal tendons were uninjured.

Where a large wound has been made in a vascular part, as by a cannon shot, or a piece of a shell; or where a deep-

prostration of strength, frequent vomiting; his countenance extremely dejected, expressive of exhaustion, a very large discharge of synovia, which, upon pressure, flew from the small orifice in a stream. The man was sinking fast, and there was no other alternative than amputation, or a free dilatation of the fascial coverings of the joint, and capsular ligament, supported upon the principle directed in your treatise, in case of Gun-shot Wounds, where the ball is fixed in the bone of the joint. I therefore freely dilated the fascial aponeurosis covering the capsular ligament, and then the capsule itself, passing the knife in at the puncture. The wound was covered with lint, and a tepid solution of Opium ordered to be constantly applied to the knee and limb. The Bark, Opium, Wine, and nourishing diet were ordered. The synovial discharge gradually abated, and in about eight weeks my patient was perfectly recovered, with a tolerable use of the limb."

seated artery of difficult access has been wounded, if the patient has been so much exhausted by the bleeding, as to render it improbable he can support the steps which are necessary to secure the vessel properly, and that the risk of this is greater than that of amputation, as the lesser evil must always be preferred to the greater, the operation, doubtful as its success will be, should yet be performed; and if the patient's accommodations, and surrounding circumstances are favourable, it may probably succeed.

In the recurrence of hæmorrhage from new, or inaccessible vessels, gradually debilitating and exhausting the patient, amputation, though very precarious, is often the only resource.

The peculiar treatment required in wounds of the Viscera, Head, &c. will be the same in those which are made by

Gun-shot, as in other wounds of the same parts; except in the particulars already described, or those which will be included in the subsequent Chapters.

VI. ON THE TREATMENT REQUIRED AT FIRST BY GUN-SHOT WOUNDS IN GENERAL.

It has been a subject of some difference in opinion among Surgeons, whether all Gun-shot wounds should not be immediately dilated by the knife. But the controversy may perhaps be contracted into a very small compass: for, if a Gun-shot wound must be dilated, the dilatation is to do something. By considering therefore what is wanted to be done in any given case, and what dilatation can, and cannot do, it will not in general be difficult to determine respecting the propriety, or impropriety of performing it. It seems absurd to make the rule to dilate so very absolute, that a man must inevitably be cut, because he has had the misfortune to be shot.

There is moreover, a time for all things. Many wounds which will require

dilating, may not require it immediately. Dilatation may cure what it cannot prevent; and prevent what it cannot cure. Nor is it always possible to say at first to what extent, or in what direction, the dilatation which will most probably be needed, had better be made.

In the preceding chapters several cases have been pointed out, in which immediate dilatation is absolutely required. It will often be needed in the first instance to expose or secure a bleeding vessel; to extract extraneous bodies, and splinters of bone; to give vent to air or blood oppressing the lungs, the brain, or other important parts; and in some instances to effect the reduction of a difficult compound fracture. Here the Surgeon's anatomical knowledge must govern his knife, and he will cut boldly, but not rashly.

On this subject it must be observed, that most Gun-shot wounds which have penetrated an Aponeurosis or Fascia, will

sooner or later require dilatation. But it will often be best performed when inflammation has come on, or when suppuration has actually commenced: Because it is under these circumstances that the advantages of it are felt; and therefore they will best dictate the situation, extent, and direction, in which it may most advantageously be performed. Where however the entrance of a ball which has penetrated a fascia will be a depending part, the orifice may as well be somewhat enlarged immediately, in order to afford a more ready escape that way for the fluids that will be effused. The dilatation can be extended afterward, if circumstances require it. But where the path of a shot lies only along cellular membrane, immediate dilatation may certainly be dispensed with. And so also where the wound is sufficiently patent to afford a ready exit to whatever must come away. Obtaining a discharge of blood from the wounded part, is seldom, if ever, of itself, a sufficient reason for immediate

dilatation, as blood may be evacuated, either generally or locally, by milder methods.

These circumstances being attended to, as a Gun-shot wound in any part except cellular membrane, is not likely to heal by the first intention, and not always even in that, the dressing must be so managed as not to interfere with the process of suppuration which is to follow, but rather to promote it. A small bit of soft lint may be placed lightly between the lips of the wound in order to keep it from closing. In some instances it should be introduced a little beyond the lips, in order to conduct off the fluids effused, and to prevent irregular adhesions from forming near the surface during the inflammatory stage; as these would impede the direct exit of the discharge. But the wound is not to be filled with lint, much less to be crammed with it: For nature will be as much offended with what the Surgeon does, as with what the

enemy has done, if it put her to pain, and do not contribute to relieve her.

A pledgit of some simple ointment being then laid on, with tow or cloths to receive the discharge, and these prevented from coming off by a bandage loosely applied, the patient may be put to bed; and so placed, if possible, as to keep the orifice of the wound dependent: but it must not be pressed by being lain upon. No medicines should be introduced into it; except where they are required to restrain the bleeding. For medicines are as really extraneous substances as bullets, and nature must always get rid of them before she can accomplish her work. A proper dose of opium, however, should be given internally as speedily as possible.

Broken bones are of course to be reduced if possible, in the first instance, and proper splints, &c. employed to retain them.

VII. ON THE TREATMENT OF GUN-SHOT WOUNDS DURING THE INFLAMMATORY STAGE.

Inflammation is a greater degree of action in the arteries of a part, than can be continued without deranging its functions or its structure. This action of the arteries may be increased in strength, but not in frequency; or in frequency, but not in strength; or both in frequency and strength. Now as the proportion between the action and the strength varies exceedingly in different cases, and under different circumstances, he who is able well to discriminate these differences, and to adjust his mode of treatment accordingly, has made no mean progress in the knowledge of his profession.

A sufficient degree of inflammation to produce suppuration over the wounded surfaces, must take place in every Gun-shot Wound, in order that its surface

may become able to form granulations, and to repair the injury that is committed. It must be the grand endeavour of the Surgeon to prevent the inflammation from going beyond this necessary degree; which however it will often be impossible for him to do, on account of the extent and complication of mischief which is produced in the wound.

But in order to do it as far as it can be done, he must not only pay attention to the action of the vessels, but to those additional symptoms which often supervene, and by which the efforts of nature are always impeded, and sometimes completely overturned.

We must therefore now consider the management of the inflammation itself, and that of the accidental symptoms.

In order to judge correctly of any inflammation, we must attend to the part in which it is situated. For the vessels

nourishing parts which differ much in their structure and office, are not capable of entering into inflammation exactly alike. In parts whose vessels carry but little or no red blood, inflammation, when once excited, generally spreads fast to a great extent, and their feeble powers are soon overdone by it; so that they die, and slough. Other parts can support it longer; and their inflammation, *cæteris paribus,* is more circumscribed. Who has not had occasion to remark the differences between the appearances after an inflammation of the pleura, and an inflammation in the substance of the lungs? Or between an inflammation confined to the skin, or cellular membrane, and one equally violent, which seizes an aponeurosis, a tendon, or a bone.

Hence it follows, that to conduct inflammation safely to an issue, not only must the action of the vessels in the part be diminished, but in some parts their powers must be diminished likewise, for

a time; while in others, their powers must be increased.

The effects, or as some express it, the sympathy, produced in the constitution by a local inflammation, will generally bear a very close analogy to the particular circumstances of that local inflammation. And so also should the treatment. A patient should not be bled as freely for an inflamed fascia, as he should for an inflamed intestine.

There are few cases in which inflammation spreads rapidly, and to a great extent beyond the seat of a wound, unless the powers of the wounded part, or of the constitution, or both, are considerably weakened. And if this is not borne in mind from an early period of its progress, and the treatment adapted accordingly, the patient's strength will often be suddenly sunk, to rise no more. For not only the diversity of natural structure, but that of accidental circumstances, pro-

ducing a similar difference in the powers of parts, and of the constitution, will occasion a corresponding difference in the features of their inflammations. And for this reason, Gun-shot Wounds, which are effected by a species of violence, the natural tendency of which is to debilitate the injured parts, and often those in the neighbourhood also, require a little circumspection in the application of the ordinary rules of treating inflammation. We are not therefore to employ our remedies *merely* on the speculation of what *may* happen, but must first carefully observe what is actually present, from which any indications can be drawn, and then wait to see what will really arise; and so let fact be the rule, the measure, and the absolute governor of our conduct.

Some things however must necessarily happen, and these are immediately to be taken into the account. For instance, inflammation to some degree must arise; and therefore, if there be any thing *now*

existing, which will naturally tend to exasperate that inflammation beyond its due measure, or render it irregular, or productive of more inconvenience than is absolutely unavoidable, those circumstances should, as far as possible, be removed.

Fulness of blood is a circumstance of this kind. That quantity of blood which was only sufficient for the body when the circulation was going on at its ordinary rate, and every part of it was in health, will be too much when its velocity is increased by inflammation, and some parts are rendered by an injury less able to bear its impulse than they were before. More especially will this impulse become too much for very vascular parts, and for parts of weak powers and feeble vessels; and therefore steps must be taken to moderate it, of which one of the most important, is diminishing the quantity of blood, if it have not been already suffici-

ently diminished by the hæmorrhage from the wound itself.

Such a diminution of the contents of the blood-vessels, moreover, naturally tends to weaken the action of the heart and arteries in the most powerful manner, by subtracting from them a certain portion of the natural stimulus by which their muscular fibres are excited to action; and which cannot, when taken away, be immediately renewed. Therefore whenever the action of these vessels is really, and *bonâ fide*, too strong, bleeding is the most powerful remedy that can be employed. But too great frequency of action is a very different thing from too great strength, and often proceeds from a cause diametrically opposite; in which therefore bleeding must do harm.

And here I must put in a caution respecting a very deceitful symptom which is apt to occur in many cases of Gun-shot wounds, which have been attended with

profuse hæmorrhage: Especially where, in addition to this, the lancet has been too freely employed: that is, employed so as to produce too much faintness and debility. Here, especially if the wound be in a part not essential to life, it is no uncommon thing that in a very few hours after the patient has been put to bed, and before a supply of nourishment can have produced a fresh stock of blood, a state of general irritation and fever shall arise; attended with what at first seems to be a strong pulse, but which yet is easily compressible; the apparent fulness of the stroke, arising only from the diminished tone and resistance in the coats of the arteries, which allows them to expand more by a slight impulse of the blood from the heart than they ought to do. The frequency of the pulse is great, generally exceeding 120 strokes in a minute. The skin is overspread with a hot sweat; the tongue dry, and becoming brown; and the countenance marked with great anxiety. If in this state, which may be

called a state of hæmorrhagic fever, the Surgeon is misled by the pulse to take away more blood, the patient will certainly die in a few hours. The constitution is only making a disordered effort to rally itself; and unless its exertions be moderated by opiates, camphor, and such other medicines as will allay its irritability, and lessen its action, without debilitating its powers, they will soon be irrecoverably exhausted.

Hence bleeding is only to be employed, where, and so far as, we want to lessen the quantity of blood, or the strength of arterial action. And hence, as we may want to relieve the fulness of the vessels, or lessen the action, in a particular part only, or more than in the system at large, topical bleedings are often preferable to general ones; and both may be sometimes employed, and even repeated with advantage.

Hence too in wounds of the lungs,

through which, while life continues, the whole blood must be constantly transmitted, to render it fit for the maintenance of life, nothing can be of so much consequence as keeping the quantity of blood as small as is consistent with the functions of life, till the injury is in a good degree repaired. Nor is there any case in which repeated bleedings are so well borne, and so constantly give relief. But even here it will sometimes be better to bleed often, than to bleed too largely at once.

Wherever the quantity of blood is likely to prove injurious, an abstemious diet is of the greatest consequence. For in vain is blood taken away by the lancet, if it be presently supplied again by food.

A loaded state of the bowels is another circumstance likely to exasperate inflammation. Hence the early exhibition of an aperient medicine, is always adviseable, and it should sometimes be aided by a glyster.

Pain is another circumstance which will increase inflammation, and should always be moderated by opium. But opium will not relieve the pain so well in a full state of the vessels, as when a sufficient bleeding has been employed. It is a very good method to give the first or second opiate in an opening draught.

Every violent exertion tends to increase inflammation. The patient must therefore be kept at rest; and vomitings, and spasms of the wounded part, must be calmed, according to the circumstances under which they arise; of which the fulness or emptiness of the vessels is the most important. Saline Draughts, Camphor, Castor, Musk, Opium, Volatile Alcali, or a combination of some of these; and also Wine, or even Brandy, if the debility of the patient shall call for it, may be given for this purpose. For in cases of extreme debility, the inflammation will often spread, as has been before explained, from a want of power in the

arteries to preserve their accustomed resistance to the circulation, which is now about to be accelerated by violent irritation. Such debility must therefore be removed.

For this reason also, where parts of weak powers, as tendinous expansions, or fasciæ, have been much injured; or where parts have undergone a great degree of contusion and laceration, the orifices of the wound being first covered with a pledgit of soft ointment, such applications must be made, as will at once invigorate those parts, and moderate the action of their vessels. Hence the use of diluted Spirits applied over the whole limb, or the environs of such a wound. From much experience of its good effects I can recommend in such cases, an embrocation composed of equal parts of Spirit of Wine, Aqua Ammoniæ Acetatæ, and Water. Cloths wetted with this, and frequently renewed, for the first six or

seven days, will be infinitely superior to any relaxing application.

When inflammation has actually taken place, the circumstances above-mentioned are still to be kept in view, and the treatment in great measure regulated by them. Bleeding must be occasionally repeated; but all the assistance that can be derived from medicines that have a power of moderating the action of the arteries, must also be called in. For the more the lancet can safely be dispensed with, the better: as the weakness left by bleeding is more permanent, and less easily counteracted, than any produced by the common operation of medicines. This is a great consideration in very severe wounds, where much debility is always produced in the part, and where nature has a long, and an arduous task before her. The blood is the very citadel of life; and its stores must not be expended, when those in the outworks will answer the purpose.

The exhibition therefore of neutral salts, and of antimonial preparations, especially the Pulvis Antimonialis, or a mixture of antimonials and saline medicines together, as long, and in as much, as the inflammation puts on the truly phlegmonous character, must be diligently employed; together with occasional purges, and a regimen strictly antiphlogistic. To the part itself must be applied poultices of bread and water, or bread and milk; or of water and Linseed Meal, or of bread or Linseed Meal mixed with the Aqua Lithargyri acetati composita. Such applications will conduct off the excessive heat of the part; will relax the surface, and keep it perspirable; will moderate the action of the vessels, and promote the formation of matter. In hot countries, poultices made of the pulp of the Water Melon, and other plants of that Genus, (*Cucurbita*) have been found exceedingly useful in diminishing the inflammation of wounds.

But where mixed circumstances occur, and violent action appears accompanied with diminished powers, either in the part, or the constitution, or both, a mixed plan of treatment must be adopted accordingly. And where the powers are failing altogether, there every effort must be directed, to support them, as the only door of hope through which the patient has any chance of escaping.

The former case will generally be marked by the tumefaction and redness of the part becoming irregularly or extensively diffused, and the pulse becoming more frequent, but less full, and strong. There will be much thin discharge from the sore, if the orifice allows of its exit; and the pain of which the patient complains, is generally of a violent aching, and inexpressible heaviness in the part, with less of throbbing than takes place in phlegmon.

Here a Saline mixture, joined with

Camphor, or Aromatic Confection; or a mixture of Antimonial Wine and Tincture of Opium; or in other cases, the Decoction of Bark with Aqua Ammoniæ Acetæ, or other medicines of a similar kind, guarding against an excess of action on the one hand, and direct debility on the other, will be most beneficial.

Applications of a similar tendency must also be made to the part. Fomentations not exceeding 120°. of heat, consisting of a decoction of White Poppy Heads; or a poultice made with the same; or in other instances the use of diluted spirit, or the embrocation above recommended, will be most eligible. When these cannot be obtained, other remedies, keeping the same principle in view, must be employed.

But where the powers of nature are flagging, the pulse becoming small, frequent, or irregular, the tongue dry and

brown, or the bowels lax; the part inflamed vesicating, or becoming livid, whether this be more attended with the characters of Erysipelas only, or of Gangrene also, there Bark, wine, brandy, spices, and cordials must be liberally given; and Opium also, according to the degree of pain, and irritability. The part injured must be covered with cloths moistened with Spirituous Embrocations; or poultices made with Yeast, or antiseptic vegetables, such as Bark, or Chamomile Flowers in powder, should be applied.

If the Stomach in this case rejects ordinary food and medicine, advantage will frequently be obtained from the warmer spices; such, for example, as the Pulvis Aromaticus, a scruple of which may be given every three, four, or six hours. A pill with three or four grains of Camphor, and one grain of Opium, at the same, or longer intervals, according to circumstances, will often have the happiest ef-

fects, and will neither nauseate, nor overcharge the stomach.

In most cases where inflammation attacks a fascia, or parts underneath one, it will be of the mixed kind; and if it be attended with great pain, arising from the confinement produced by the fascia, no great relief is to be expected till the fascia gives way. Therefore enlarging the original wound, to set the subjacent parts at liberty, or making incisions elsewhere, at an early period, will save the patient a great deal of pain, and often put a stop to the progress of the mischief. Such incisions must be made longitudinally, or obliquely, or transversely, as the case may require: in short, they must be what will best answer the purpose with the least inconvenience. But generally free openings will be requisite. Nothing is more futile than making petty incisions in these cases, which give as much pain as larger ones, and produce no adequate benefit.

Internal inflammations are often relieved by exciting external ones in the neighbourhood, by means of blisters, &c. But these are most successfully resorted to, when the fulness of the vessels has been diminished.

In all cases a pure and temperate air, with frequent ventilations of the chamber, are requisite.

Wherever the wound has made its way near a large blood-vessel in an extremity, a Tourniquet should be kept on, and the attendants instructed how to tighten it, if an hæmorrhage should take place.

Where large sloughs are to be cast off, their putrescency should be counteracted by antiseptic applications, which should be renewed twice, thrice, or four times a day, or oftener, till the eschars are completely detached: And when they are large, and beginning to loosen, scarifications through them, without wounding

the subjacent living parts, will often expedite their exfoliation, and prevent the retention of putrid matter underneath them.

And if by these, and other analogous means, the patient can be conducted through the first inflammation, and an healthy suppuration be produced over the wound, his sufferings will generally abate, and his prospects will begin a little to brighten. But, alas! the danger is not yet always at an end. Other sources of anguish and peril may yet exist, by which, perhaps, he may notwithstanding be finally overwhelmed.

——————— Longa est injuria; longæ
Ambages: sed summa sequar fastigia rerum.

VIII. ON THE TREATMENT REQUIRED AFTER SUPPURATION HAS TAKEN PLACE.

When an healthy suppuration is established, the surface from which it takes place is brought into that state at which the restoration of the lost parts is commenced, and by a continuance of which, the cure, if it be practicable, is to be accomplished. To remove the obstacles to this work is the Surgeon's next duty.

From the history which has been given in the former part of this treatise, of the formation and structure of the granulations which shoot out on the surface of a wound from which suppuration has taken place, it will evidently appear, that if they are perfectly healthy, the less they are disturbed, the better. Dressing a simple sore with dry lint, covered over with a pledgit of mild ointment, will suffice for the external treatment; and a

gradual return to the patient's ordinary diet, will reinstate the vigour of his constitution.

When suppuration comes on, the inflammatory symptoms in general go off, and the swelling abates. It should not however entirely disappear; and even its abatement should be gradual, and the other symptoms should be mitigated in proportion. For if, at any period, the swelling suddenly subsides, while the frequency of pulse, the debility, want of appetite, and restlessness, continue or increase, the death of the patient is at no great distance. The most powerful cordials, and especially aromatics, should then be given, but unfortunately they will in general have but little effect.

In hot countries, and in hot seasons, maggots are very liable to infest gun-shot wounds. They are not in general of much consequence, except for the present irritation they give. Le Dran has

justly observed they never appear but in healthy sores, or where a slough is exfoliating. They cannot live in the acrid discharge of an unhealthy wound. They should however be removed; and they may often be killed by washing the part with a strong infusion of wormwood in water or spirit, or the application of spirit in which camphor has been dissolved.

Pus is the natural secretion of an ulcerated surface: but it cannot be furnished, nor can the process of healing go on, without an increase of action in the contiguous arteries. For as they have not only to nourish the parts which they supply, but also to produce new ones, they must act more on that account. This exposes them to irregularities, to excesses, and to deficiencies of exertion, which must be treated, when they occur, upon the same principles as have already been pointed out, in directing the conduct of the inflammatory stage. When

however the action of the parts is languid, local stimulants, such as the digestive ointments, &c. must be applied.

Pus, moreover, though the secretion natural to a sore, is yet an unnatural discharge; taking place in no instance without a sore, or some state of a secreting surface analogous to that of a sore: so that it is a discharge superadded to the natural ones. If therefore it be abundant, it will in time, and perhaps in a very short time, undermine the strength, and bring the life of the patient into hazard. His vigour will fail; the tone of the vessels will diminish; the secretions of the natural emunctories will escape too rapidly; perspiration from the skin, mucus from the bronchiæ, bile from the liver and gall-bladder, mucous and serous fluids from the coats of the intestines, and perhaps also urine from the kidneys, will be poured forth in too great abundance; all these evils will reciprocally increase each other; and at length, nature, un-

able to support or overcome them, will abandon the patient to his fate.

Such is frequently the unfortunate issue of cases, where the bones, or the joints, have been much shattered; and often of those where only a large portion of flesh has been carried away; especially if it have been removed in consequence of sloughing, during the occurrence, or especially from a repetition of the inflammation.

Hence, whenever an extreme part in these circumstances is so situated that it can be removed, amputation must be resorted to, if it can be performed above the seat of the mischief, and if a sore of less magnitude will be left after the operation, and the strength of the patient is equal to it.

But large sores, accompanied with great mischief to bones, and even to joints, will sometimes do well, with time,

patience, nourishment, and suitable medicines. Therefore as long as the patient is able to take supplies proportioned to the discharge, keeps up his general health, and a natural appearance of his countenance, and the occasional irregularities which take place in the system, yield to appropriate remedies, not only may amputation be deferred, but it certainly ought not to be performed; unless it be evident, from the very nature of the mischief that is done, that the operation must sooner or later be called for. If indeed this be the case, the patient's strength should not be too far trifled with, or exhausted. A little debility however, previous to the operation, will rather facilitate his recovery. In short, things should have gone just so far, that nature may feel that the operation rids her of an incumbrance, from which she could not deliver herself.

Profuse discharges are often kept up from the wound by the continuance of ex-

traneous substances, which may now be searched after with more freedom, when the parts have got into a quiet state. Splinters of bone will also have the same effect; and where either the former or the latter have not been, or cannot be readily removed, or sloughs have not been completely discharged, abscesses will form, which should always be freely opened as soon as they point externally. A free exposure of their cavities will not only facilitate the exit of any thing which is to come away, but will generally be followed by a more speedy and perfect amendment in the part. Indeed the confinement of matter any where will always do harm, and should as much as possible be prevented by a suitable position, and proper openings.

Some parts however may be treated with more indulgence in this respect than others. Matter confined under the cranium, or within the cavity of the Thorax, is so very unlikely to gain an exit without the assistance of art, that an opening must

be made to evacuate it as soon as ever its presence can be ascertained. Its continuance must in a short time produce irremediable destruction.

But to support the patient under all these trials of his strength and patience, and to bring him happily through them, will require a supply of nourishment equal to the discharge; and generally the assistance of tonic medicines; and of opium, to allay irritation and procure rest. Wine, or other fermented liquors, and sometimes even brandy, must also be allowed, in proportion to the debility which takes place; for which they are in general more effectual remedies than any in the Materia Medica. The efficacy of the Cortex Cinchonæ officinalis, and other plants of that genus, is well known. These may be exhibited in substance, or in decoction, infusion, &c. either alone, or combined, where little accessions of fever come on, with some acid, or a neutral salt.

It was in these cases that Mr. Ranby recommended the exhibition of bark, and at the same time occasionally taking away small quantities of blood. But so frequent a repetition of bleeding will generally be rendered unnecessary by joining with this drug the Aqua Ammoniæ Acetatæ, or a neutral salt, as has just been recommended. If notwithstanding this addition, a febrile diathesis should prevail, and contra-indicate the bark, its use had better be suspended for a time, and it may afterward be resumed to greater advantage.

In some cases however, such as those in which the Lungs have been injured, these medicines can seldom be exhibited. The great resource of the patient is in a light vegetable and milk diet, with pure air, warm clothing, quiet, and the occasional use of the mineral acids; of which the Sulphuric is upon the whole to be preferred, as it is generally least disgusting to the Stomach, and its use can be longer persisted in. It may be given in the

Infusion of Roses; and half a grain or a grain of the Sulphat of Zinc in each dose, will sometimes be found a very useful addition.

The air of the country, and of a temperate region, are in such cases almost indispensable. Without these, and a rigid observance of a light diet, and the strictest temperance, the hectical symptoms will most probably increase, and the patient will at last be cut off.

Si vero tristi languebunt corpora morbo,
Quod jam non dubiis poteris cognoscere signis,
Continuò est ægris alius color; horrida vultum
Deformat macies: tum corpora luce carentum
Exportant tectis, et tristia funera ducunt.*

In many cases fistulous sinuses remain for a long time, owing to the discharge of some secreted, or excrementitious fluid, from the wound having penetrated the organ containing or secreting it. These will often heal up of themselves, by time, if cleanliness is sufficiently regarded, and

* Virg. Georg. Lib. 4. 251.

the general strength can be kept up. Sometimes a secreted fluid may be constantly directed to its natural outlet, either by a new opening, or the introduction of an instrument, so as to divert it from the sinus, which will then generally heal up. Thus the cure of a sinus communicating with the bladder, may be facilitated by wearing a flexible Catheter.

Where a sinus remains open without any evident cause, it is most probably owing to some extraneous substance lodged in it, or to some little splinter or scale of bone, which may perhaps be entangled by passing a seton, and thus brought away. I have known a sinus remain open for many months, by a very small bit of the coat having lodged in some part of it.

But where wounds have passed through fasciæ, particularly those of the forearm and leg, they will often continue open, merely from want of vigour in the

parts to shoot out healthy granulations. In such cases, stimulating them by the introduction of a seton; or scarifying their orifices a little freely, will make them first inflame anew, and then heal up: a process which nature sometimes spontaneously adopts.

Where a wound is kept open by the exposure of bones which are to exfoliate, time must of course be given for their separation, before they can be extracted. This will generally be accomplished in a period of from six weeks to as many months. And it will often be expedited by a free exposure of the exfoliation, and by keeping the inside of the sore clean, and dressing it with antiseptic medicines, or a solution of nitrous acid in water. But large exfoliations, though really having no remaining intercourse with the vessels of the living bone, are often retained in connection with it by the irregularity of their edges. Indeed they may be so for years: but if they remain long, the living bone will shoot out osseous

matter around them, and lock them in faster and faster, and they will then produce additional mischief, to which there will be no end till they are removed.

Whenever therefore it may be concluded, from the lapse of time, that a separation of the dead bone from the living has taken place, if it be accessible, attempts should be made first to loosen, and then to extract it: and openings must be made, and force, sometimes great force, employed for this purpose, if necessary. It is ridiculous to wait, expecting a piece of bone as big as a finger, to come out of an opening no bigger than a pin. I hardly know of any case in which parts will bear so much force without mischief, as in the removal of exfoliated bones.

But where the situation of the bone is absolutely inaccessible, or it cannot be distinguished, or removed, without danger, time, cleanliness, and an attention to occasional circumstances, and to the

general health, are for the most part the only remedies.

Saturnine ointments will often form the best dressings for parts thus exposed to a continual exciting cause of inflammation.

But other diseases may be excited in bone by wounds, and sometimes even by the continuance of dead pieces within them. To enumerate these would be irrelevant in the present dissertation, as they are by no means peculiar to Gun-shot Wounds. I shall therefore for the present here close the consideration of a subject, which is unfortunately of too much importance in the present state of mankind.

From barb'rous Turkey to Britannia's shore,
Opposing int'rests into rage increase;
Destruction rears her sceptre; tumults roar;
Ah! where shall hapless man repose in peace *.

FINIS.

* Merry's Elegy on the Plain of Fontenoy.

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ADVERTISEMENT.

THE favorable reception this little work has received, having already rendered a *third* Edition of it necessary, I cannot deny myself the pleasure of inserting the following Resolution of the Royal College of Surgeons in Ireland, which I had the honor to receive soon after its first publication.

" At a Meeting of the Royal College of Surgeons in Ireland, holden on Monday the 5th of November, 1804;

FRANCIS M'EVOY, Esq. President, in the Chair,

The Secretary having laid before the College a Treatise on Gun-Shot Wounds, by Thomas Chevalier, Esq. of London, accompanied with a letter from him, requesting their acceptance of the said Treatise for the use of their Library,

Resolved, That the thanks of the College be returned to Mr. Chevalier, for his very able and useful Essay, and that the Secretary be directed to express to him their *unanimous* concurrence with THE ROYAL COLLEGE OF SURGEONS OF LONDON in their approbation thereof.

Extract from the Minutes.

J. HENTHORN, Sec."